





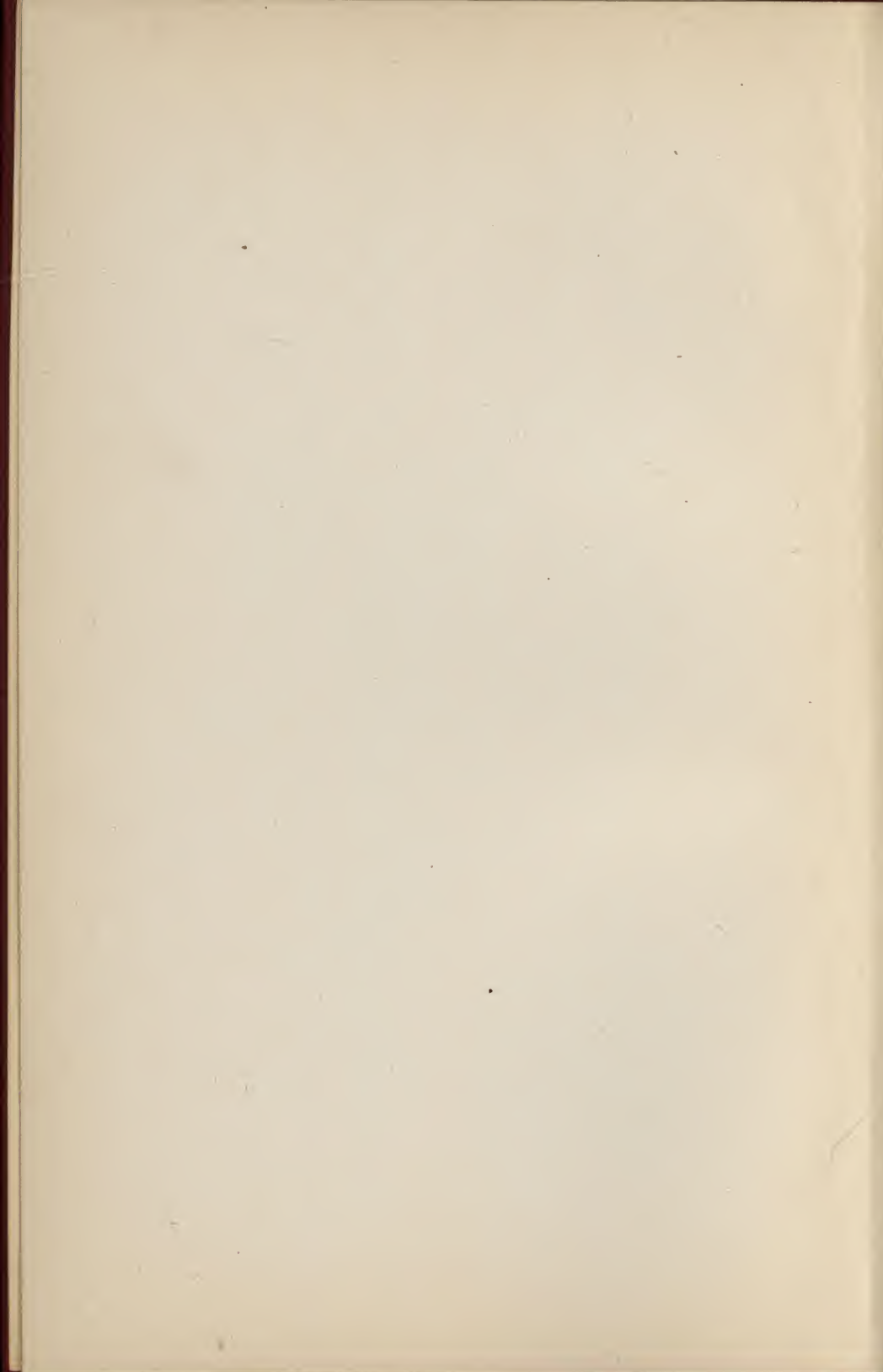
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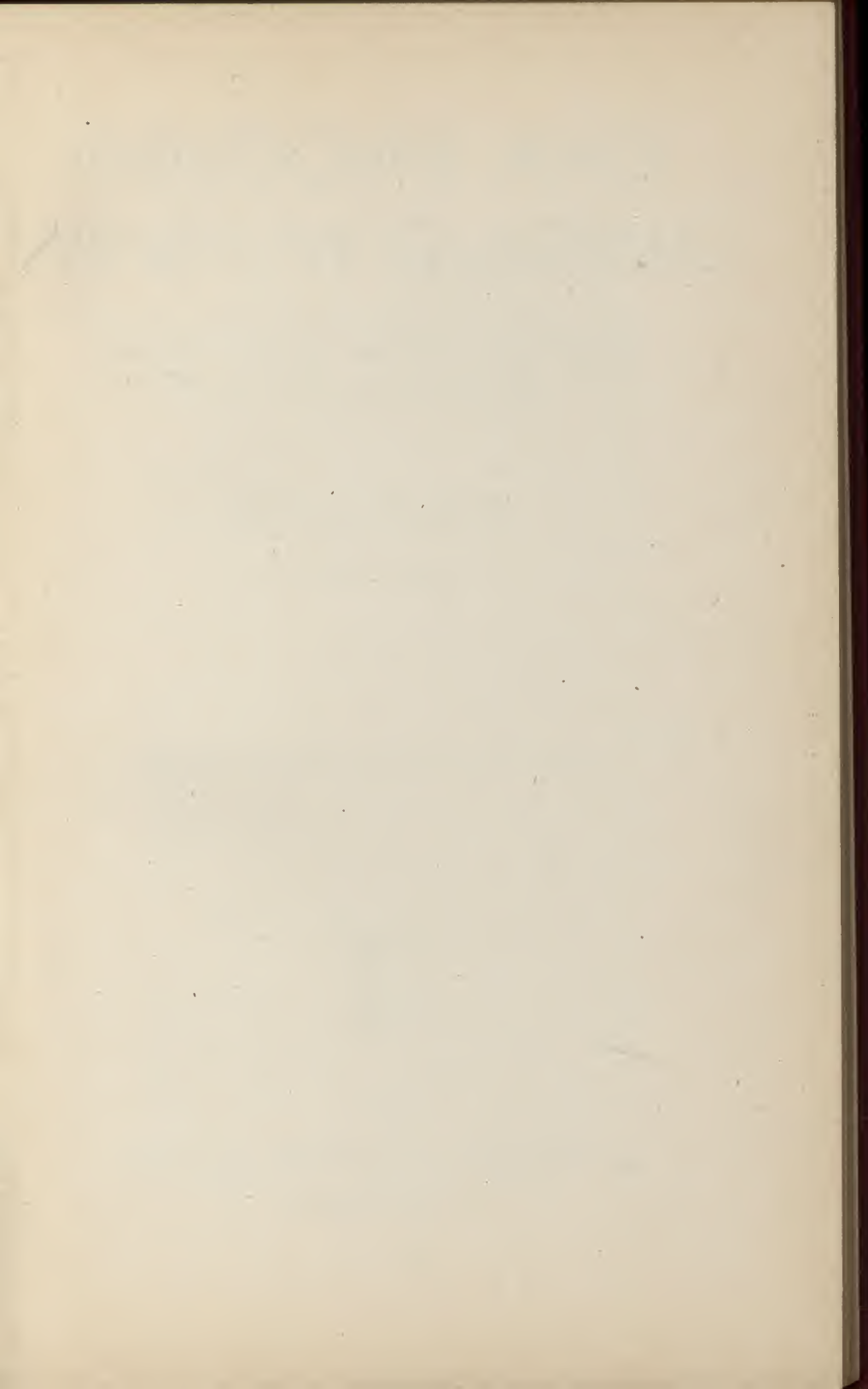
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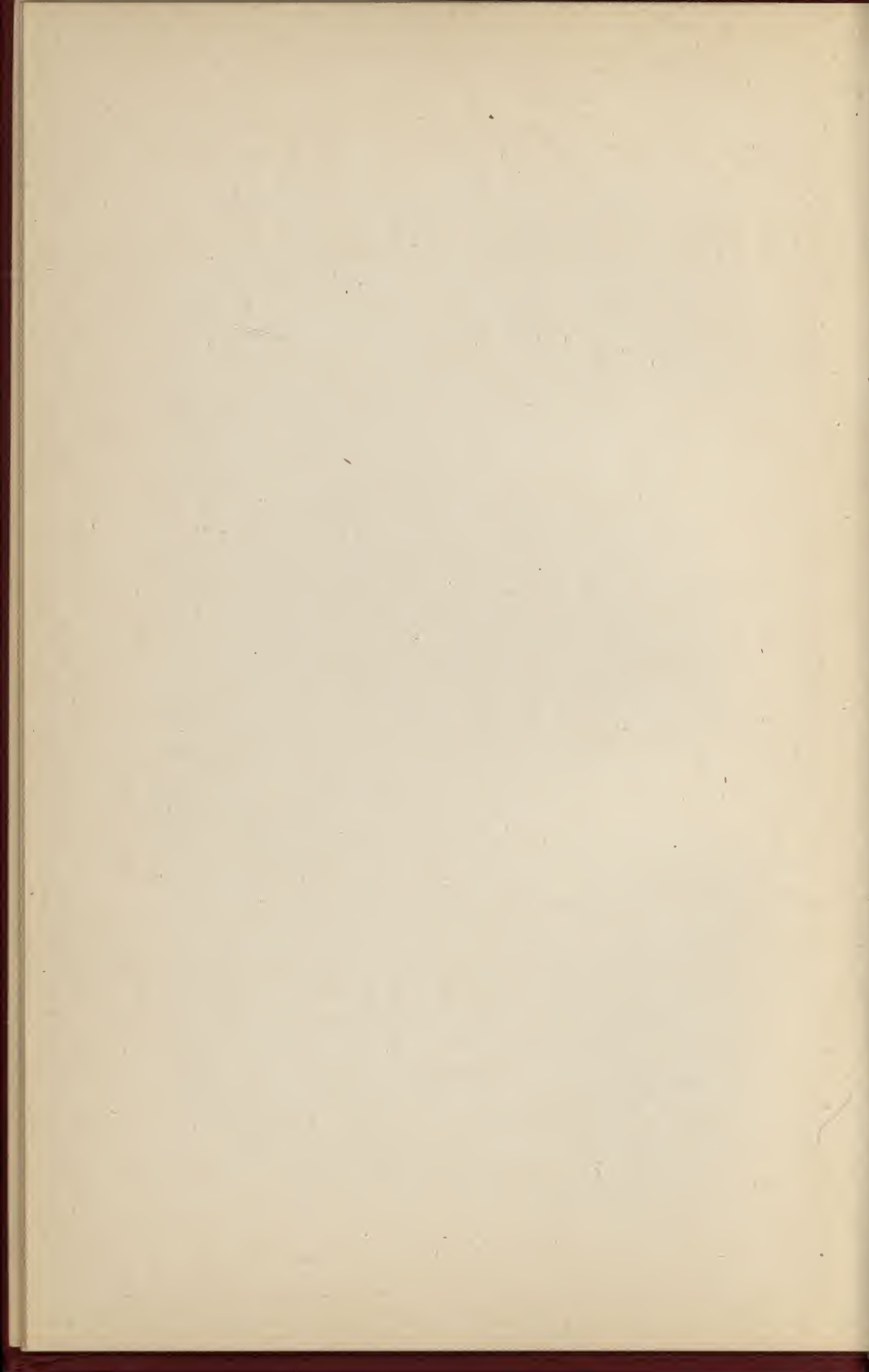
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WINDOWS AND WINDOW GLAZING

DEALING WITH THE CONSTRUCTION OF WOOD-
AND METAL-FRAMED WINDOWS, METHODS OF
GLAZING, FITTINGS AND FASTENERS. WITH
NOTES ON METAL SHOP FRONTS

*Prepared by a Staff of Technical
Experts under the direction of*

E. MOLLOY

WITH ONE HUNDRED AND EIGHTY ILLUSTRATIONS



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PREFACE

BOTH the construction and reconstruction of windows of all types are subjects which are likely to be of outstanding importance for some time to come. The present book has been planned to assist those responsible for window construction and window glazing in all their varied aspects.

In addition to the usual types of wood-framed and metal-framed windows, windows used in domestic buildings, commercial premises, and the subject of metal shop fronts have also been dealt with. The methods of glazing to be employed in different types of windows have been described in detail. It will be appreciated that when very large areas such as are found in modern shop fronts have to be glazed or reglazed, a special technique is required for handling the large sheets of glass which are necessary for this work. In this connection, it is of interest to note that any sheet of glass which exceeds two feet in its shortest superficial dimension requires at least two men, if it is to be handled in safety. The manipulating of the very large sheets of plate glass which are used for shop-window glazing may require six men or more if the risk of breakage is to be avoided. The precise methods to be adopted in packing, lifting and fixing are described in detail in Chapter III.

Two aspects, one representing the modern trend, and the other representing well-tried methods which have been in use for hundreds of years, form the subjects respectively of Chapters VI and VII. Chapter VI deals with the use of pressed and moulded glass as a medium of construction. Chapter VII deals with the subject of leaded lights.

The final chapter has been devoted to the subject of fittings and fastenings suitable for use with various types of windows and fanlights.

It is hoped that the bringing together in a convenient form this varied information of the important subject of glazing and window glazing will prove of real utility to practical men as well as to apprentices and trainees entering the building industry.

E. M.

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WINDOWS AND WINDOW GLAZING

Chapter I

WOODEN-FRAMED WINDOWS

WINDOWS are one of the most essential parts of a building, of whatever character that building may be, and it is intended in this chapter to deal with the various types of wooden frames which are in constant use.

The Horizontal Sliding Sash

Perhaps the simplest form of a window frame is the solid frame with a sash sliding horizontally, sometimes called a "Yorkshire light." This is a very old-fashioned type, which may be seen in old cottages, and in later years has been employed on some municipal housing schemes. The frame has usually two or three sashes, only one of which slides. Fig. 1B shows the construction. It will be noticed that only the inner sash is movable. This frame has the advantages of simplicity and economy, as there are no expensive fittings, and the method of securing the opening sash can be simply a bolt to the cill. One of the disadvantages is that the groove in the cill, in order for the sash to slide, renders it difficult to keep out the rain, but this can be obviated to some extent by the use of a metal bar, which also will allow the sash to run more easily. Other disadvantages are the clumsiness of appearance, the liability of the sash to jam, and the difficulty of cleaning the outside.

Vertical Sliding Sashes

We naturally turn next to the well-known "sash windows," or vertical sliding sashes. This was a great feature of Georgian architecture, and is very typical of the period. During the nineteenth century scarcely any other type was employed. It is still used in many cases, though not greatly for domestic work unless the design of the building renders this style of window almost essential.

This window is the only one of the series we describe that is constructed with a boxed frame. The jambs are formed of two long shallow "boxes" (see Fig. 2), to enclose the weights which will balance the two sashes. Two shallow grooves are formed by the lining and beads, in which the sashes slide up and down. The long cast-iron weights inside the box are secured by hemp cores, which pass over wheels or pulleys fixed in a pulley stile, and are nailed to the sashes. Access to the weights,



Fig. 1.—"LUMEAH," CHURCH, SURREY. WEST FRONT

A design for which vertical sliding sash windows are suitable. The residence of a general practitioner, with separate entrance on the south side with a staircase leading to waiting-room on the first floor for panel patients. House built of multi-coloured local facing bricks with wide mortar joints. Woodwork externally painted cream. Roof of local brown hand-made tiles. (*Architect: W. J. Palmer-Jones, F.R.I.B.A.*)



Fig. 1A.—DESIGN WITH
ARCHED SLIDING
SASH WINDOWS

House of brick, with cream cement rendering, and reddish-brown pantile roof. (*Architect: C. J. Fawcett Martindale, F.R.I.B.A.*)

if required, is obtained by a "pocket piece" in the pulley stile. The cill is solid, and usually double-rebated; as in all windows, this is the danger-point, where rain is most likely to drive in.

The construction appears somewhat complex, but one great advantage

is that the window can be opened slightly at the top, and give ventilation with less likelihood of draught than is probable with a casement, which must be open all the way down. Also, by using a very deep bead and bottom rail at the cill (Fig. 3), the bottom sash can be lifted and give a little ventilation between the two meeting rails, without the window being directly open at all.

There are, however, several disadvantages to this class of window:—

The sashes are very apt to jam, may be troublesome to open, more particularly the top sash.

Also, the sashes are very much inclined to rattle in a strong wind, so much so that small wedges have often to be used to silence them on a windy night.

Sooner or later the cords will wear out, two to three years being the average life of a cord. Then, rehanging of the sashes becomes necessary, a job that can only be undertaken by a competent workman. In better-class work chains are used instead of cords, and naturally last much longer.

The sashes, also, are difficult to clean externally.

In order to render the labour of opening less difficult, finger lifts should be screwed to the bottom rail of the lower sash, and it might be emphasised that, as a considerable strain will come upon the screws, there should be at least four to each finger lift. In some cases it is impossible for a person to lower the upper sash when he or she is standing on the floor, in which case a loop is screwed to the top rail, and the sash lowered and raised by means of a rod with a hook at the end.

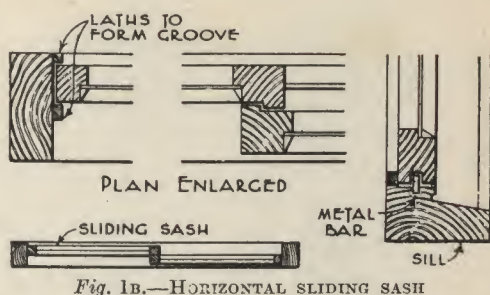


Fig. 1b.—HORIZONTAL SLIDING SASH

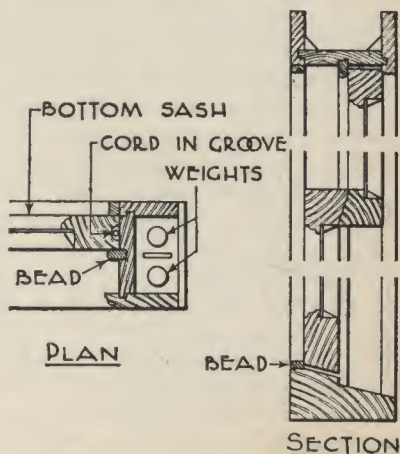


Fig. 2.—VERTICAL SLIDING SASH

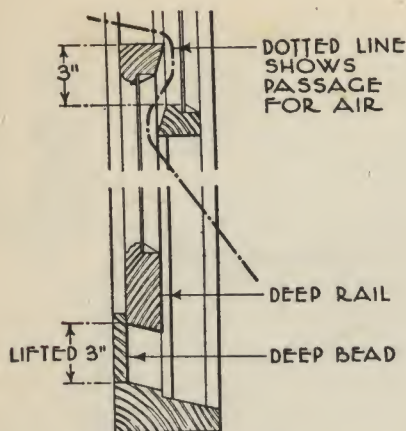


Fig. 3.—VERTICAL SLIDING SASH WITH DEEP RAIL

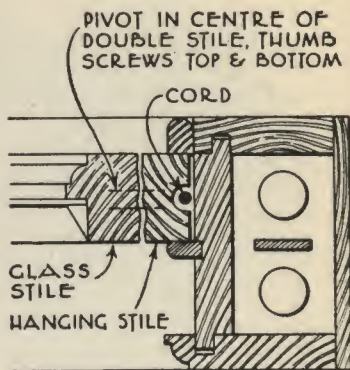


Fig. 4.—SASH WINDOW—DOUBLE-STILE PATTERN

It should be mentioned that in some of the cheaper work, only one sash (the bottom one) was made to slide, but generally this form of window was specified as "double hung." Also, in some of the eighteenth-century buildings the windows are divided by mullions. These mullions are naturally very wide, as each one has to contain the weights for four sashes. This, however, is somewhat uncommon.

Double-stile Sash Windows

At one period an ingenious variation of this window was on the market. The stiles of the sashes were made in two pieces: one, the sash or hanging stile, and the other the glass stile (Fig. 4). The slight grooves were intended to check the draught. The inner or glass stile was secured to the hanging stile by thumb-screws in cups, and with a pivot in the centre. On the screws being released the inner sash could be pivoted "inside out" for cleaning purposes. It must be noted that the double groove allows sufficient "play" for the inner sash to open. Otherwise, the construction is similar to the ordinary sash window.

Hopper Window

The next type of window to describe is the hopper. This is usually employed only as an upper or transom light. It is hinged at the bottom (Fig. 5), and falls inwards, generally opened by a rack opener and endless cord. If carelessly left open it is liable to let in the rain and wind; also, like all windows that open inwards, it interferes with the curtains, and the hanging cord is apt to be a nuisance. Rain and draught can be checked by providing fan-shaped glazed sides for the sash to fall back, but these

are very unsightly, and again there is the question of the curtains. Clearly, this is not a window suitable for domestic work.

The Push-out Transom Light

A better pattern for a transom light is one which, for want of a more suitable term, we may call a "push-out." Instead of being hinged at the bottom, as the last, it is hinged at the top, and is pushed out and secured by the ordinary casement stay (Fig. 6). It is a very simple type, but certainly can be used only as a transom light, and the transom must be low enough to allow easy reach for opening. There are special fittings to be obtained for opening this type, operated by a cord, which push the sash outwards. Should this sash be a wide one, two openers are required. This window has one great advantage—it can be safely opened during wet weather, a quality which most other windows lack.

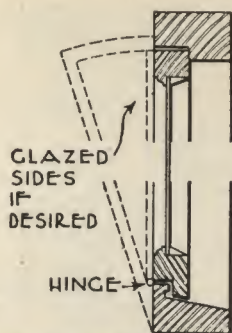


Fig. 5.—HOPPER WINDOW

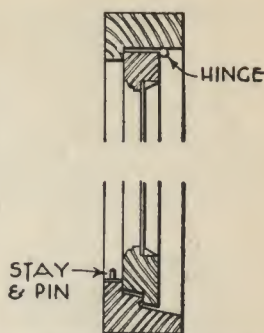


Fig. 6.—"PUSH-OUT" TRANSOM LIGHT

The Side-hung Casement

There is little doubt that to-day the popular type of window is the side-hung casement. It is generally in a frame which is divided by mullions into two, three, or more lights, and with or without transom as the case may be. A point that may be discussed is: What should be the width of a casement sash? The standard size fixed by the manufacturers of steel frames is 20 in. over all, but the average builder, with his wooden sashes, usually makes them 24 in. to 26 in. It is probable that the width of 20 in. was fixed as being quite wide enough to pass the arm round for purposes of cleaning and also a narrower width is less likely to be affected by the wind.

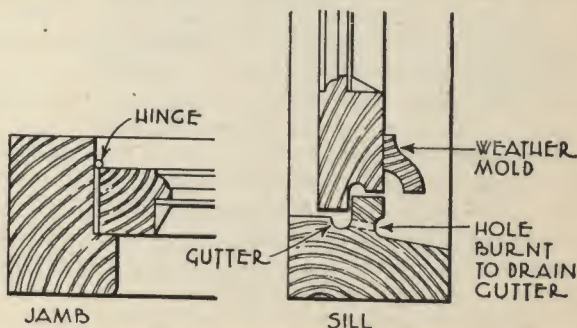


Fig. 7.—CASEMENT OPENING INWARDS

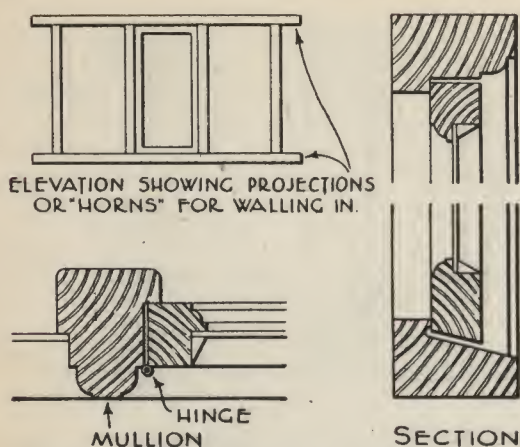


Fig. 8.—CASEMENT OPENING OUT—ORDINARY TYPE

pattern of window is rarely used, but where it is used, water should be kept out as shown in Fig. 7. Note the weather mould planted on the bottom rail, the rebate and groove in the cill. The latter should be of a generous width, to take any possible leakage, and should have holes at intervals to lead any water that may have collected in this small gutter to the outside. It might be emphasised that these holes should be charred after boring.

Casement Opening Outwards

The casement opening outwards is possibly the most-favoured type of window to-day. It is quite obvious that the rebate, being placed in the opposite way to the last case, will better serve to keep out the weather. Fig. 8 shows the usual and most economical method of construction, but if a double rebate or sinking be made in the cill, and the grooves as shown in Fig. 9 are ploughed in both sashes and frame, it renders the whole window more watertight. It might be noted that the groove in the top rail of the sash should be slightly sloped so as to run the water off at each side. The main disadvantage of this type of window is the difficulty of cleaning, but if projecting hinges are used, the sash can be opened far enough back to allow the arm to pass between it and the frame. In a three-light window, as far as cleaning goes, only the centre light need open. It should be pointed out also that if the window is opened the stay-bar should be at once fixed, as the sash exposes quite a fair amount of surface to the wind, and a sudden gust might easily rip the sash off its hinges, or at any rate strain it.

Another objection to it is that it can rarely be opened without more or less draught, and also that in damp weather it is apt to swell, and if well

Casement Opening Inwards

A plan and section of the casement sash opening inwards are shown in Fig. 7. It is quite obvious that any form of sash opening inwards is more difficult to keep watertight than one opening outwards, as it is plain that, in the first case, any wind pressure has a tendency to push the sash open, whereas in the latter case the effect of the wind is simply to close the sash tighter. This

fitting be somewhat troublesome to open and close. This last remark, however, applies equally to all wooden frames.

In spite of all these objections, however, this form of window is probably the best for ordinary use.

Occasionally, casement sashes, whether outward or inward opening, are hung folding, that is, without a centre mullion, one sash being closed and bolted to the cill and head, and the other secured to it. In this case the "hook" joint, as shown in Fig. 9, is advisable, and a bead should be nailed to the sash last closed to cover the joint.

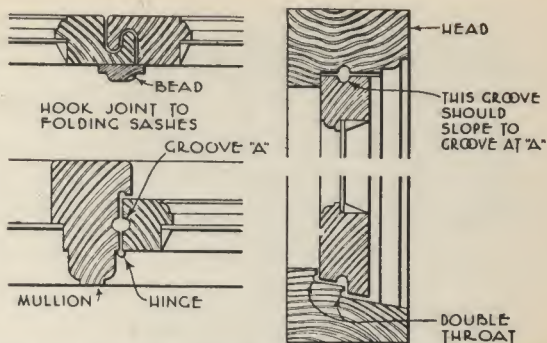


Fig. 9.—CASEMENT OPENING OUT—ANOTHER TYPE, SHOWING GROOVES

" Storm-proof "

As already mentioned, the most vulnerable point for weather in casement windows, or indeed in all types of window, is the cill. With a strong driving wind, heavy rain will stream down the window, and in spite of throating, grooves, drips, etc., the water will at times drive up under the sash.

There are special forms of the casement window for preventing ingress of rain-water, such as the "Storm-proof." Fig. 10 shows this window with transom light. The series of grooves, to catch any water and stop its further progress, will at once be noticed. Note the following: the shield to prevent water from finding entrance; the double rebate in both frame and sash; $\frac{1}{8}$ in. clearance, so

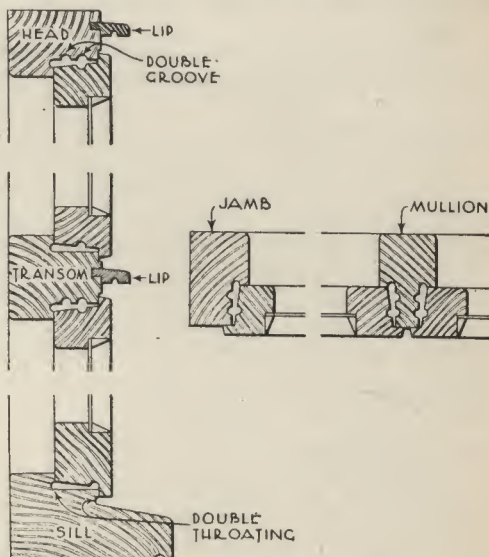


Fig. 10.—"STORM-PROOF" WINDOW

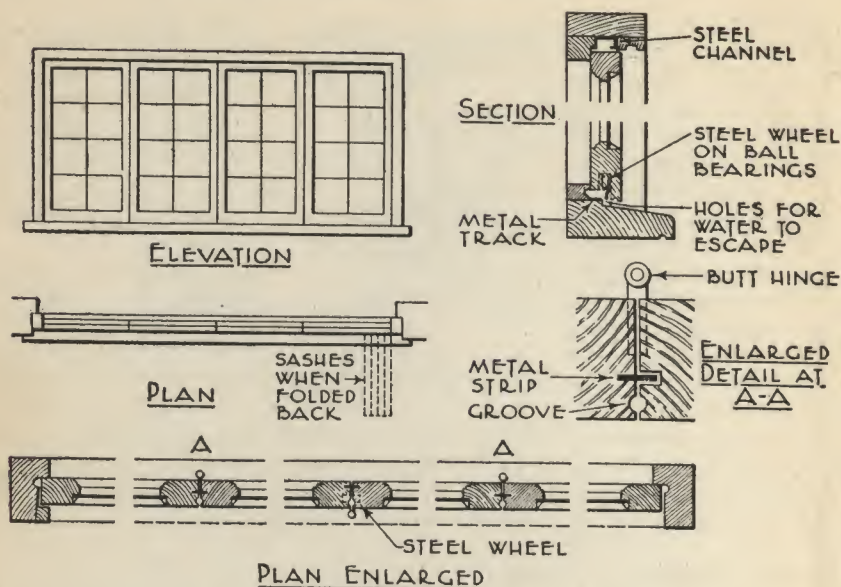


Fig. 11.—FOUR-LIGHT FOLDING SASH

that the sash will not bind with any swelling; and double throat in cill.

There are also other similar patents, such as "Ti-foon," which appear to be equally commendable.

Folding Sashes

The Educational Supply Association has patented a folding window, as Fig. 11, where the four sashes fold together, the sashes and centre upright sliding on a brass track on a wheel on ball-bearings, somewhat after the manner of the folding shutter. Though the drawing appears to be somewhat complex, the working of the window is very easy, and a large space can be thrown open to the air and sun. It should be noted that when fully opened the strain is not entirely on the hinges. Also another point is worthy of notice: the metal track which forms a gutter to catch the water that may be driven in is pierced with holes to allow the water to escape.

Centre-pivot Sash

Another class of useful window as a top light is the centre-pivot sash. This sash simply works on a couple of centre pivots, fixed horizontally, and if high up is usually opened by means of a cord. The rebate is formed by a double bead, part nailed on frame and part on sash.

Vertical-pivot Sash

The vertical-pivot sash is occasionally employed (Fig. 12). Here, as the term implies, the window sash is fixed on two pivots top and bottom. It is not a common type, but is found at times in the upper storeys of factories.

In the illustration given, it should be noted how part of the bead, on both outside and inside, is nailed to the frame, and the continuing portion to the sash, thus preserving the appearance, but frankly, the section of the cill does not appear to be absolutely weathertight.

The main advantage of pivot-hung windows, whether vertical or horizontal, is ease and convenience in cleaning.

The Sash Bars

All these various types of sash may be divided by sash bars. In nearly all these division bars, the rebate and the putty are outside, though a better but unfortunately more expensive method is to have the rebates inside, and to fix the glass with wooden beads.

Reveal or Flush Fixing?

The window frame may be fixed flush or nearly so with the external face of the wall, or the usual method of allowing a $4\frac{1}{2}$ -in. external reveal may be followed. Each method has its advantages, the first mentioned allowing a broad internal window cill, but the last named is generally considered as the more watertight one. If the two sections in Fig. 13 be studied, it will be observed that in the ordinary method, water running down the face of the wall will find it more difficult to penetrate at the window head. If the check or recess of the brickwork be observed, and the frame be flush, water can trickle over the head and down inside the frame, whereas, in the case of an external reveal, the check of the brickwork will interfere with this. If it is specially desired to fix the frame flush, a course of tiles as a drip above the frame is desirable (Fig. 14). Unfortu-

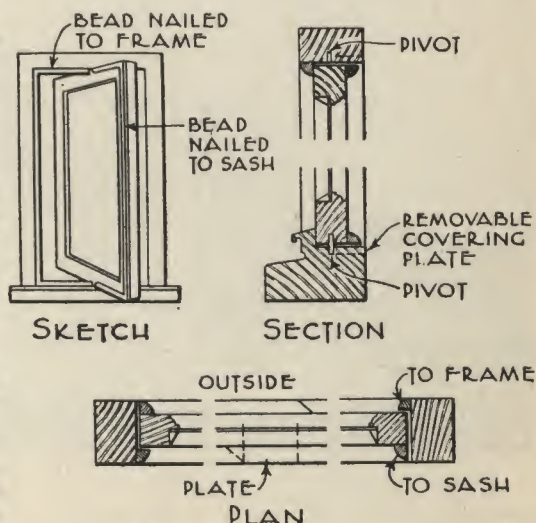


Fig. 12.—VERTICAL-PIVOT SASH



Fig. 12A.—HOUSE NEAR MARLOW, BUCKS

A long, low house with wooden side-hung casement window treatment. Built of multi-coloured bricks and hand-made sand-faced tiles. (*Architect: G. Berkeley Wills, M.C., F.R.I.B.A.*)



Fig. 12B.—"WEST END," FRENTHAM, SURREY

The above house was once an ugly Victorian red-brick villa. The picture shows the result of conversion. Note the sliding sash windows. Local red facing bricks are used. Low-pitched roofs of Cornish slate. Columns to portico, cornice, etc., are of deal, painted cream. (*Architect: W. J. Palmer-Jones, F.R.I.B.A.*)

nately, these are rather brittle and very likely to crack, and certainly could not be used with a boxed frame. Another point in favour of fixing the window frame in reveal is that there is more space available for the curtain brackets, which, if a frame is fixed flush, is likely to be considerably reduced (Fig. 14), unless exceptionally heavy frames be used.

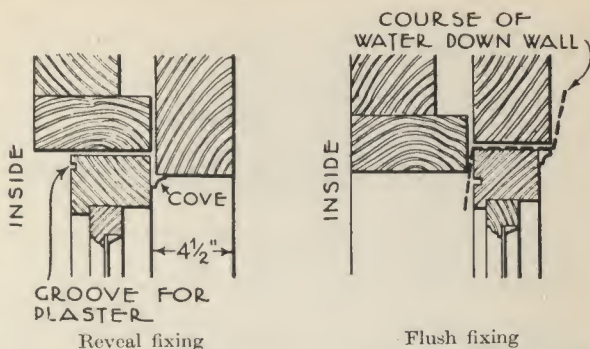


Fig. 13.—REVEAL AND FLUSH FIXING

When to Fix the Frames in Building

Another matter often discussed is whether the frames should be built in as the work proceeds, or whether the openings should be left in the brickwork and the frames fixed afterwards. The former method is considered by many to be the better: it is argued that the frames will be firmer and the heads and cills can be about 3 in. longer each side (see Fig. 8), thus giving a firmer grip in the wall.

Finish Externally and Internally

All frames are pointed to the brickwork externally, but this pointing has an unpleasant habit of dropping out. If a bead or cove mould be sprigged to the frame (Fig. 13), after pointing, this is impossible. With regard to the internal reveal, whether this be finished with plaster or a wood lining, the frame should be ploughed or grooved to receive the desired finish.

Metal windows are largely used in the building trade, but it is improbable that the demand for wood frames will die out. Several firms in this country make a speciality of these.

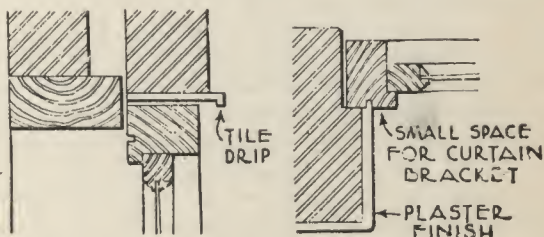


Fig. 14.—TILE DRIP FOR FLUSH WINDOW FIXING

Chapter II

METAL WINDOWS

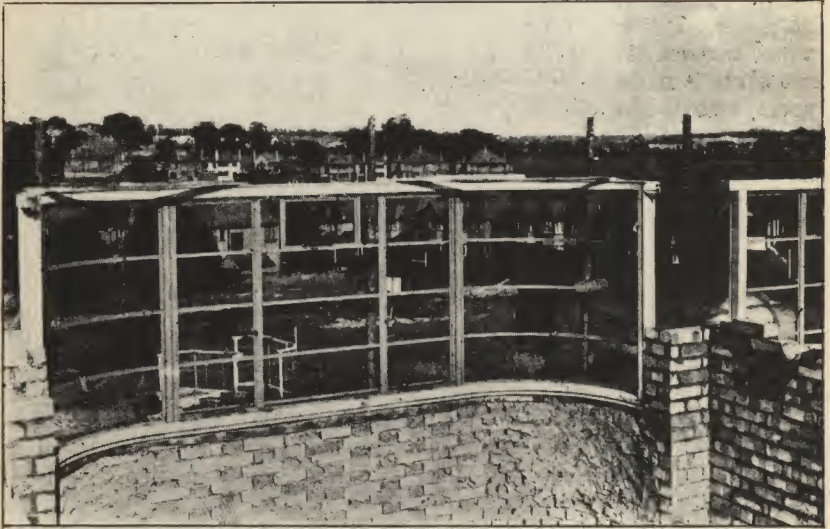


Fig. 1.—CURVED METAL CASEMENT BAY WINDOW WITH WOOD SURROUND

The use of the wood surround renders the fixing of this type as simple as that of a wood casement window.

METAL windows have firmly established themselves as an alternative to almost any type of wood window, including cased frames. The result is that the onus is upon everyone actively interested in the building industry to become acquainted with the new conditions due to their use.

What are Standard Windows ?

Windows constructed upon certain unit principles such as size, design, and methods of glazing have led to the standardisation of those most suitable for everyday requirements of the building industry.

Fig. 2, while not depicting all the types of standard windows, gives a very good idea of the principles adopted. For example, one can readily see that differing designs and widths are made in standard heights, a point that facilitates the designing of an elevation where the height of windows must be uniform. Or, again, differing designs and heights are

made in uniform widths, for use in elevations requiring this type of treatment.

Other features of standardisation are glazing and hanging. Under the first, windows are made with or without glazing bars, to enable the use of leaded lights or large panes as desired. The second has been rendered necessary from the point of view of balancing the design and the necessity of being able to open a window in opposite directions.

Special Types and Sizes

Metal windows can be made to special sizes if required and also to special types differing from standard construction. Openings can be placed in any positions to suit the particular buildings for which they are intended.

A case in point is the ground floor of a school where windows of the ordinary side-hung types opening outwards to a playground would be very dangerous if the sills were less than 6 ft. from the ground. To overcome this difficulty a type of window, bottom hung, opening inward to a restricted angle, can be made.

Factory Sashes

The modern forms of factory and similar buildings call for exceptionally large window space, and to supply this need special metal windows are made known as "factory sashes." They differ from the domestic types in several features, mainly in their size and method of ventilating, for it will be seen that while it is simple to fit an ordinary house with windows having the whole of one or two of their sashes to open, this would not be practical with windows having a height of anything up to 9 ft., by 5 ft. or 6 ft. wide. The difference between these types of windows is shown by the domestic window in Fig. 3 and the factory sash in Fig. 4.

METAL WINDOWS

Why a Metal Frame is Watertight

Fig. 5 is a section through a wood casement and explains how water is kept from percolating to the interior of the window by its construction.

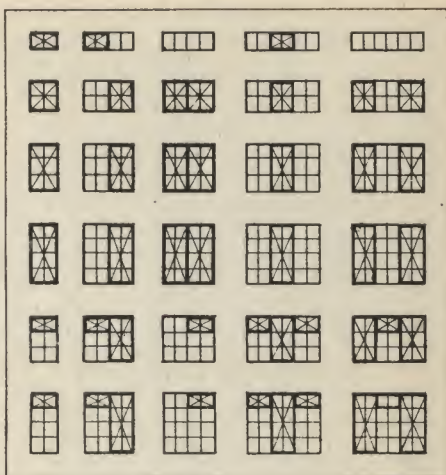


Fig. 2.—SOME OF THE TYPES OF STANDARDISED METAL WINDOWS

This illustration shows the principles of standardisation of sizes, widths, and types. The crosses denote opening portions.



Fig. 3.—A "STANDARD"-TYPE DOMESTIC WINDOW
This is of the outward-opening type with night vent
and fitted with glazing bars.

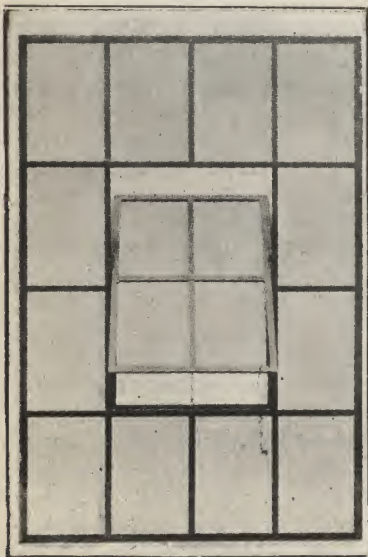


Fig. 4.—A "STANDARD"-TYPE FACTORY
SASH WITH CENTRE-HUNG VENTILATOR

Something of this principle is used in the manufacture of metal windows, and Fig. 6 shows a section through a similar opening casement made of metal by which the same water-tight result is obtained. The outer frame "A" bears hard upon the inner frame "B", thereby sealing the opening. The spaces marked "C" act as check grooves. The illustration in Fig. 6 is an outward-opening type. The same water-tightening principle is used with regard to inward-opening types, where it concerns the head, but the bottom edge must be fitted with a weather bar as shown in Fig. 7.

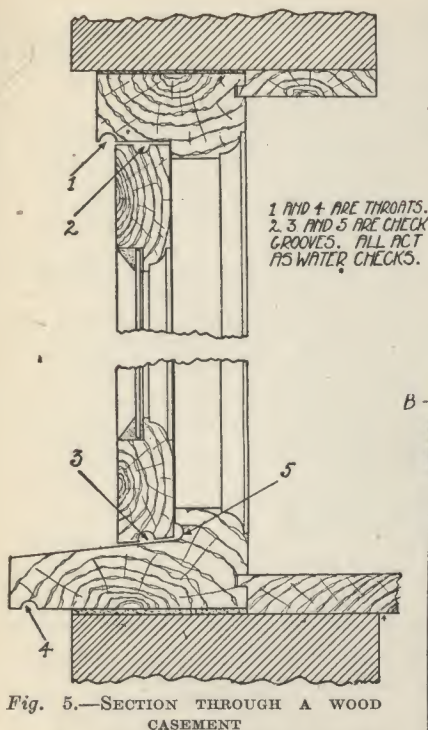
Fixing Windows Direct in Brickwork

In most building works it is the carpenter's job to prepare the windows and to offer them into position for the bricklayer to build up to. He must therefore be conversant with the methods by which the whole opening is rendered watertight in addition to the opening sashes as explained above.

Fig. 8 is a typical detail of a metal window fixed between walls showing the construction at one of the jambs. These windows are supplied with steel lugs on all four sides to be embedded in the brickwork.

Fixing as Work Proceeds

Having placed the window in position and being assured that it is



The throats and check grooves shown are designed to prevent water entering by capillary attraction, the first by causing the water to drip before reaching the adjacent surfaces and the second by interrupting the capillary tube.

Making Opening Watertight

When the work is completed the whole opening is rendered watertight by means of the cement fillet as shown in Fig. 8. This is bedded in by the brick-layer as the work proceeds, and by the mastic pointing between the steel frame and the brick jamb.

Where the windows are in-

perfectly vertical, it must be held in this position by means of a temporary strut fixed obliquely. This precaution, of course, is only necessary where the windows are being built in as the work proceeds, for the windows can be inserted in prepared openings left in the brick-work, although this method, besides being more costly, is likely to result in the openings being a fraction too large or too small to ensure a good fit.

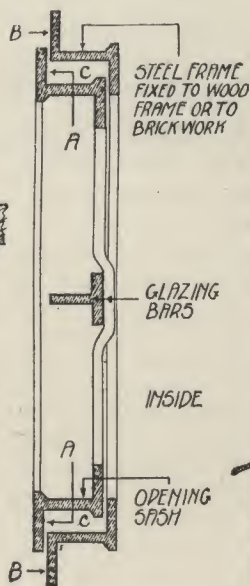


Fig. 6.—SECTION THROUGH AN OUTWARD-OPENING METAL WINDOW

The capillary attraction referred to in Fig. 5 would occur between surfaces A and B, but water is prevented from reaching the interior by the check C.

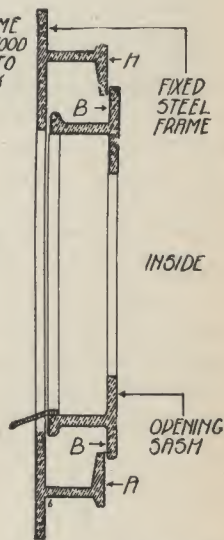


Fig. 7.—SECTION THROUGH AN INWARD-OPENING METAL CASEMENT

To prevent water entering, the bottom edge must be fitted with a weather bar as shown.

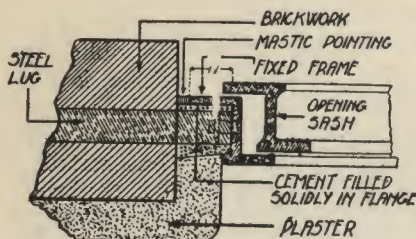


Fig. 8.—FIXING THE WINDOW BETWEEN WALLS

The flange must be fitted solid with cement and the mastic pointing carefully inserted.

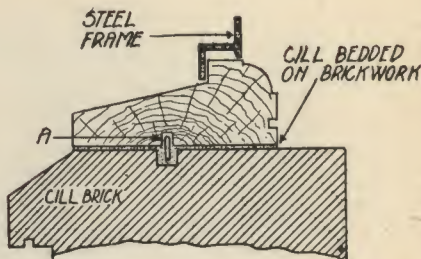


Fig. 9.—A WOOD CILL SET BEHIND THE FACE OF BRICKWORK

The cill must be bedded on a cill brick or stone cill which must project to allow the throat to overhang the brickwork.

serted in prepared openings, great care must be taken to see that the frame is properly bedded with the cement fillet, as this is frequently omitted in slovenly work and often leads to a great deal of trouble.

Head of Frame Should Bear no Weight

It should be noted here that the head of the frame should always be prevented from carrying any weight, and the lintel, steel joist, brick arch, or whatever method of construction is used should be so built to avoid this. Even the slightest sinking may tend to buckle the frame and thereby break the joint and allow the ingress of water.

Wood Cills and How to Fix Them

When the windows are built direct to brickwork there are various forms of cills that can be used. One is a wood cill which is bedded direct on brickwork before the insertion of the window, and this in its turn can be fixed in various ways. Fig. 9 shows a cill set back from the face of the brickwork, and it will be seen that if the water bar "A" is omitted rain water is likely to percolate between the joint and so find its way to the interior of the building. If the cill is grooved and a metal bar, preferably galvanised, is inserted, the ingress of the water is retarded.

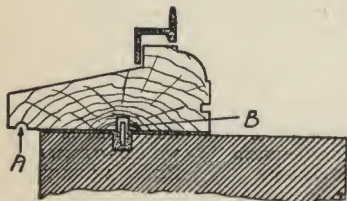


Fig. 10.—DIAGRAM SHOWING CILL SET PROJECTING

In this case the wood cill projects and requires the throat formed on its under side.

A cheaper form of construction can be made by carefully bedding this groove on a cement bed, at the same time ensuring that the groove is completely filled with the cement, which, provided it is properly done, forms an efficient water check.

When it is required to set a wood cill behind the face of the brickwork, either a stone or tile cill or cill brick must be used in conjunction, as is shown in Fig. 9.

Another Method of Fixing Cills

Another method of fixing the cill is shown in Fig. 10. In this case the cill projects beyond the face of the brickwork. It is essential that the throat "A" be formed on the under side as shown, and it is advisable that the water bar "B" is inserted.

Wood cills should be formed as shown with a $\frac{1}{2}$ -in. external rebate to form a bed for the metal window, and should be well weathered. Too often is the scarcity of weathering found to be the cause of many water troubles with window fixings.

Stone Cills

The same method of construction and fixing applies equally to stone cills, the only difference being that these should be carefully plugged opposite the respective fixing holes with hardwood plugs.

When the cills are in position and are set, the windows should be bedded by filling the channel of the frame with a special mastic supplied with them and the whole pressed against the rebate. The screws can then be inserted, care being taken not to twist the frame in the process.

Fixing Windows with Tile Cills

Another method of forming a cill, mostly used where windows are built direct into face brickwork or into rough-cast work, is by means of tiles. Where these are used they should be laid first and allowed to set. The windows should then be placed in position and cement grout poured through the fixing holes.

An alternative method is to see that the channel is well filled with cement mortar and the frame pressed well down to make a firm bed before fixing screws are inserted. When the frame is fixed in this manner



Fig. 11.—METAL CASEMENT WINDOWS IN POSITION

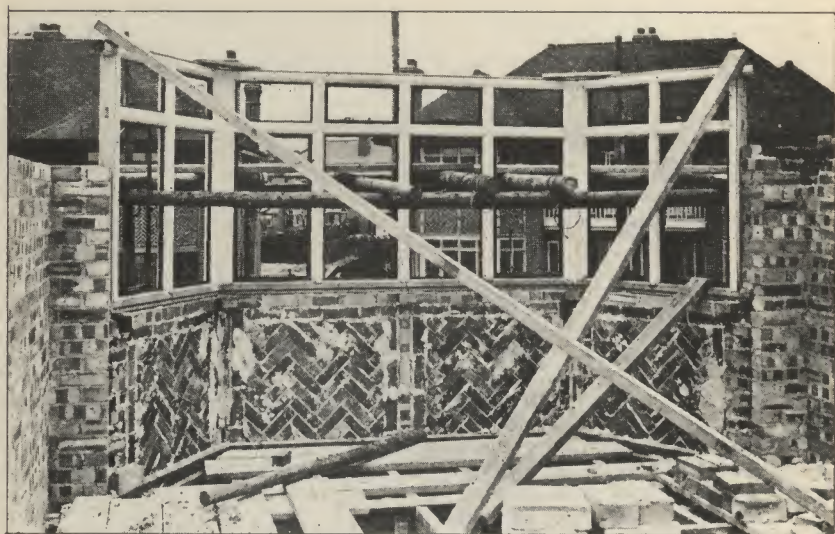


Fig. 12.—WOOD BAY FRAME WITH METAL CASEMENT BRACED READY FOR FIXING

it is very difficult to use the fixing lugs which are supplied with the windows. The writer has found by practical experience that it is better to poise the window on blocks and build in the lugs in the brickwork of the jambs only, leaving sufficient space on the under side of the window for the tiles to be inserted later.

Tile cills can also be fixed when wood frames are used.

Fixing the Tiles

This is a point to which particular attention should be paid. Examine Fig. 14 and notice that the tiles are laid with a considerable slope; this is to avoid rain remaining on the surface and being driven inward by means of the wind between the edge of the window frame and the tile, should the pointing at any time become loose.

The overhang of the tile beyond the face of the brickwork should be at least 1 in. to $1\frac{1}{2}$ in., and preferably the lower tile should be of the continuous nib type, the nib acting as a drip to prevent the water finding its way along the under side.

Types of Frames to Use in Rough-cast Walls

So far the types of windows that have been explained are manufactured of a standard width of section—that is, the distance shown at “A,” Fig. 8, is usually about $\frac{3}{4}$ in. When the wall is to be rough-cast this distance is insufficient, as the distance between the walls is reduced by about 1 in. or the thickness of the rough-cast on either jamb, the rough-cast in its turn

interfering with the action of the hinges. To overcome this a window is manufactured with what is known as a wide or long flange, and in these the width "A" referred to is increased by $\frac{1}{2}$ in. It is necessary to state this when ordering windows to be used under these conditions.

Fixing Window Boards

The method of fixing window boards where metal windows are used depends largely upon the type of cill that has been fitted. Fig. 15 is an illustration of the fixing used where the window was built direct between walls to be rough-cast, and in which the internal reveals are to be plastered.

A good fixing to the brickwork beneath is obtained by driving properly shaped wood wedges between the joints and nailing the window board thereto. A good finish can be obtained at the corners by allowing it to run by and returning any moulding appearing on the front edge. The plaster is then brought down on top of the board. Fig. 15, however, shows another method—that is, to fit the board between the jambs, so that when the wall and reveals are plastered the slightly rounded edge projects beyond the plaster.

As there may be a tendency for window boards to warp slightly, due to dampness through an open window, the worst case being in an upward direction, the joint between the under side of the board and the plaster



Fig. 13.—THIS PHOTOGRAPH SHOWS HOW THE ANGLE-IRON TIE IS INSERTED IN THE CORNER OF A BAY OVER A METAL CASEMENT WINDOW

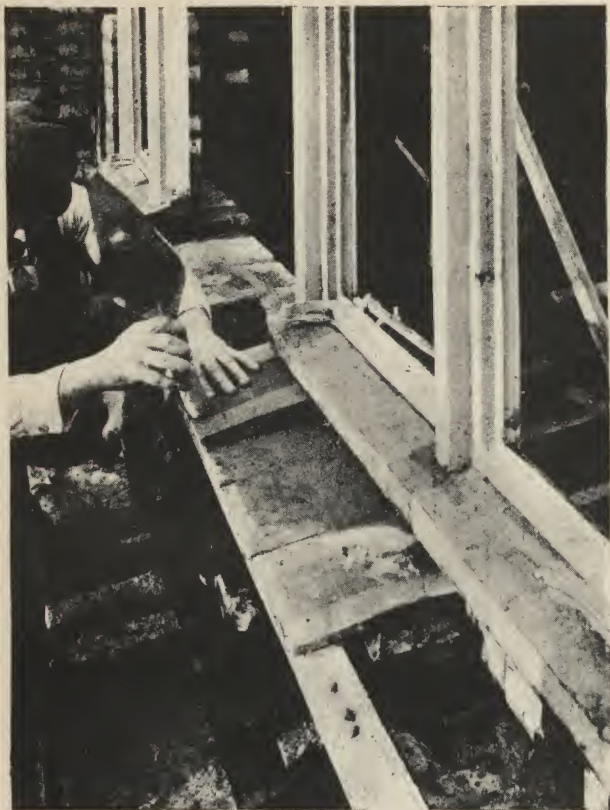


Fig. 14.—METHOD OF FIXING TILE CILLS

Tile cills must also be laid weathered. A batten is fixed along the front edge at a slightly lower level and the tiles packed at the back to give the slope.

the back edge of the board. The wedges are driven between the brickwork as before to form a further fixing, and the brickwork is brought up level with the under side of the window board.

Fixing Jamb Linings

When windows are built between brickwork it is seldom that jamb linings are used, the most satisfactory method being to plaster the reveals. If, however, they are required, in which case a soffit lining also would be required, it is essential that they should be tongued to the window board and the soffit, and further fixings made along the jamb by means of fixing bricks built in the brickwork at the specified intervals.

can be covered by a small moulding tongued to the under side and which in the case of slight warping would move with the board and yet still cover the joint.

Fixing with Breeze Bricks

Another method of securing a good fixing for window boards is to see that proper breeze fixing bricks are built in, say, at 18-in. intervals along a perfectly level surface. The boards may then be spiked to these bricks, the nails being driven in obliquely.

Where a wood cill is used the back edge should be rebated to receive a tongue on



Fig. 15.—METHOD OF FIXING WINDOW BOARDS

Properly shaped wedges driven between joints provide a firm fixing. The last course of brickwork has been left down to facilitate the insertion of the tile cill. This should be properly filled in to help secure the wedges.

Fixing Soffit

As already suggested, no weight should be allowed to rest upon the head of the window ; the brickwork above may be carried on a concrete lintel. If this is the case, the soffit must be fixed to this lintel by means of very small plugs, but taking care when inserting these not to shatter the concrete. A very satisfactory way of fixing these is to place small dovetail fillets on the shuttering before the concrete is poured, and when the shuttering is struck these fillets are held in position by the concrete. Fig. 19 illustrates this method.

Another Method

A still further method of fixing the soffit, and for that matter the front edge of the jamb linings, is to fix a rough ground along the front edge. This ground serves a double purpose : first, to take the plaster ; secondly, as fixing for the soffit linings.

Architraves

Where linings are used architraves are generally adopted and the lining should be of sufficient thickness to allow the architraves to project

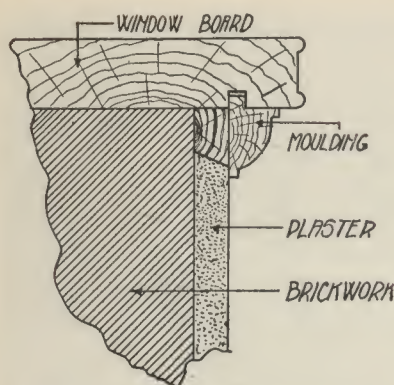


Fig. 16.—FIXING WINDOW BOARDS

A proper finish is obtained by fixing a ground as shown and then fixing a small moulding tongued into the window board.

When using these it is necessary to study the manufacturer's instructions regarding the extra height occasioned by their use, and this must be taken into consideration when calculating the size of the openings required in the brickwork.

Similarly, this same precaution is necessary when using the mullions, although in this instance no increase in width is necessary, as the mullion is taken up in the section of the frame. Some makers, however, do not adhere to type, and it is well to be on the safe side.

Composite-type Windows

So far we have dealt with ordinary standard windows that do not call for the use of transoms or mullions. It is possible, however, to couple almost any of these types together in a horizontal or vertical manner by means of steel transoms or mullions provided for the purpose.

WINDOWS IN WOOD SURROUNDS

This method of fixing metal windows has many distinct advantages over the former, especially as suitable wood frames can usually be obtained from the manufacturers, with the various types of metal windows fitted complete ready for placing in the openings. Even so, if the wood surrounds have to be specially made the advantages still exist.

The first and main one is that the fixing or building in is rendered simple, as the window is treated as an ordinary cased frame or wood

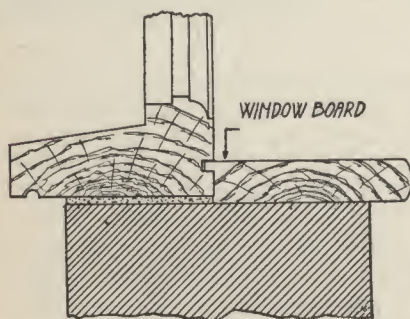


Fig. 17.—JOINT BETWEEN WOOD CILL AND WINDOW BOARD

The back edges of wood cills should be grooved to receive a tongue formed on the window board.

casement; secondly, the internal finishings become a simple matter, and generally the whole appearance is enhanced by their use.

The narrow-section windows are usually inserted in the wood frames, as the necessity for the wide flange to overcome rough-cast is non-existent, there being sufficient width on the wood surround to overcome this.

Construction of the Surround — Sizes and Timber

While no specific size of scantling is necessary for their construction, the best and most practical have been found to be as follows:—

Heads and posts out of $3\frac{1}{2}$ in. by $2\frac{1}{2}$ in.

Cills out of 6 in. by 3 in., or

Heads and posts out of 4 in. by 3 in.

Cills out of 6 in. by 3 in.

The cills, to give the best result, should be of oak, although deal is not prohibited, and is useful if a reduction in cost is desired.

Weathering

It is essential that the same attention be given to the weathering properties and groovings of these frames as was specified for the cills only. The posts are grooved on the back. This is known as a key groove, and when the frame is bedded against the jamb the cement is pressed hard into this groove and so makes a perfect joint.

The frames should also be grooved internally to receive the window boards and jambs and soffit linings.



Fig. 18.—METHOD OF FIXING FOR WINDOW BOARDS

Showing breeze bricks, to which the board may be spiked.

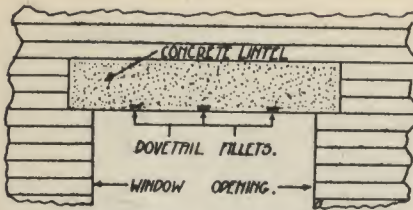


Fig. 19.—FIXING FOR SOFFIT LINING

Showing method of placing dovetail fillets in a concrete lintel to provide a fixing for the soffit lining.

the surplus of putty removed. This whole operation is a very important one, as unless it is carefully done it often causes leakage troubles.

There is no definite rule as to when the metal frames should be inserted, but if the wood frames are specially made and not supplied by the makers of the windows, it is better that they should be left until the completion of the erection of the superstructure, for the reason that the metal parts are likely to become damaged, in which case the whole window may have to be replaced.

Over-all Sizes of Windows

If the windows are to be inserted after the brickwork is built, a little more care must be given to the question of setting out the openings where wood surrounds are used, as there are many ways of coupling the various types, using the two sizes of frames given above, that must inevitably dispense with a standard size of opening. For example, two windows 1 ft. 11 in. wide may be coupled together with an ordinary steel mullion and the whole inserted in a 4-in. by 3-in. frame, the steel mullion alone being sufficient to give an increased width.

Or again a 4-in. by 3-in. frame giving an increased width over $3\frac{1}{2}$ in.



Fig. 21.—A SECTION THROUGH TWO STEEL WINDOWS FIXED SIDE BY SIDE BY MEANS OF A STEEL MULLION

Fixing the Metal Windows in Position

We have seen that in the construction of the frame a $\frac{1}{2}$ -in. rebate is allowed for the bedding of the steel section, but before this is done a putty or mastic bed should first be laid in position as shown in Fig. 22. The metal frame of the window is then pressed firmly in position as is shown in Fig. 23, after which the fixing screws may be inserted and

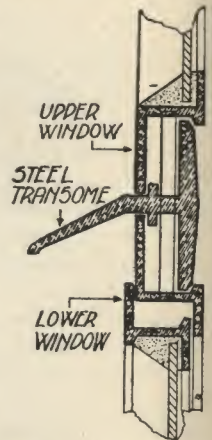


Fig. 20.—A PART SECTION THROUGH TWO STEEL WINDOWS

by $2\frac{1}{2}$ in. Another method of coupling is by using a frame with a wood mullion, this giving a still further increase in the width. These same remarks also apply to the heights, as wood transoms can be used in the place of steel, which latter cause a reduction in



height as compared with those using wood transoms.

Figs. 24 and 25 show sections through a composite window using a wood mullion and transom respectively.

Methods of Building In

The practice here does not differ greatly from that of the ordin-

Fig. 22.—FIXING METAL WINDOWS IN WOOD SURROUND

A putty bed must be formed to ensure a water-tight joint between the wood and metal frames.

ary steel frame, except that the wood frame complete with cill is placed in position in one operation. It will be noticed in Fig. 22 that the frames are supplied with their heads projecting beyond the posts, and although not illustrated the cills are extended in a similar manner. This is done in order that sufficient timber may be left on



Fig. 23.—METAL FRAME IN WOOD SURROUND

After the putty is inserted the metal frame is firmly pressed home and fixing-screws inserted.

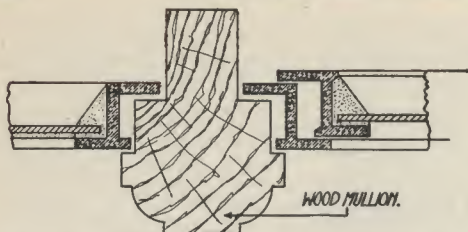


Fig. 24.—SECTION THROUGH A WOOD MULLION USED TO COUPLE THE STEEL WINDOWS

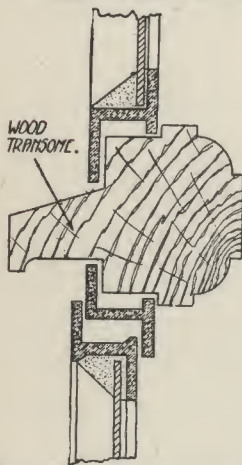


Fig. 25.—SECTION THROUGH WOOD TRANSOM

Note that the bottom front edge is treated in the same manner as the head of the frame and serves as a drip or throat.

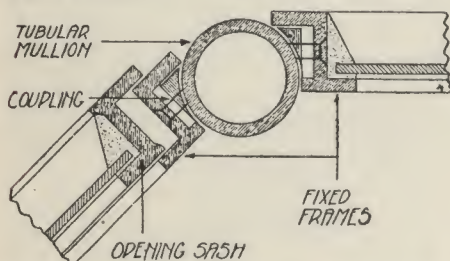


Fig. 26.—SECTION THROUGH TUBULAR STEEL MULLION

This type of mullion is used for coupling windows forming bays. The windows can be fitted at any angle desired.

the morticed members to allow for the tenons being properly wedged without splitting. While some of this timber must be cut away if the frames are to be inserted in face work, it must not all be cut, as otherwise the object of these "horns," as they are called, is nullified.

To provide similar fixing to the jambs as is done by means of the lugs supplied with the metal frames, it is usual to fix at intervals strong hoop-iron ties, screwed to the back of the frame and extending into the brickwork.

In the case of the cills there are several methods of treating them. For example, it is not necessary to cut these when building in, as the brickwork can be bedded direct on to the extension, thus forming a weight holding the frame in position. If, however, the frames are to be inserted in prepared openings with the cills projecting beyond the face of the brickwork, then a right-angled notch should be cut in each end in order that the front of the cill may run past the reveals. There are other ways of dealing with them, all depending upon the architectural effects used in the building, but the main point to remember is that these horns are left for a purpose.

Interior Finishings

These can be carried out in two or three different ways. Window boards may be composed of quarry tiles bedded to brickwork and the plaster continued into the reveals with a cover moulding covering the joint between the frame and plaster, or the openings may be fitted with window boards and linings.

Assuming the latter to be

the case, the jamb linings should be housed to the window boards and tongued to the soffit lining, and all linings and window boards should be tongued to the frame. A practical method of fixing is to assemble the framing complete before placing it in the opening, when the tongues can be gently forced to the grooves in the frame.

It is sometimes, however, impossible to do this, as for example where the window board is made in one piece to extend across two or more windows. This latter is then first placed in position and the remaining linings properly fitted to their grooves.

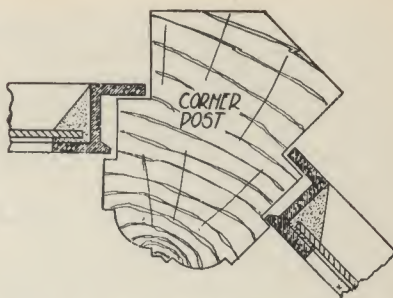


Fig. 27.—HOW THE FRAMES ARE MADE
Showing a solid corner post used for bay windows.

BAY WINDOWS

Windows without Wood Frames

Metal windows can be adapted to suit many types of bays by the use of mullions or corner posts. Fig. 26 shows the arrangement at one corner of a bay using a tubular mullion that is in common use, and these can be supplied to give varying angles. By coupling these mullions with the various types of standard windows any combination of bays can be set up; for example, three-sided, five-sided, or about semi-circular, and, in addition, can be used to form oriel windows.

Windows with Wood Frames

In this type we get several variations in the manner of assembly. Fig. 28 is a typical section through the posts of a pair of standard windows fitted

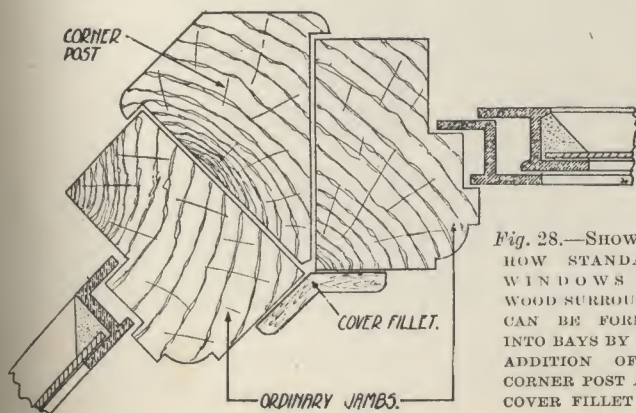


Fig. 28.—SHOWING HOW STANDARD WINDOWS IN WOOD SURROUNDS CAN BE FORMED INTO BAYS BY THE ADDITION OF A CORNER POST AND COVER FILLET

to form the corner of a bay, and shows the insertion of a corner post to overcome the difficulty of filling the angle. By this method it is possible to couple any of the standard windows into the bay to give any desired result.

Chapter III

HANDLING AND CUTTING GLASS

DO not attempt to handle alone any piece of glass that exceeds the length of the arm on its narrowest width. Anything larger than this is unmanageable, and breakage is certain to result.

Handling Large Sheets

With large sheets of glass, do not allow the material to "take its own weight," either in lifting it or when resting against the bench, since the unsupported weight is often sufficient to cause fracture.



Fig. 1.—PACKING LARGE SHEETS OF PLATE GLASS

Packing the last square into case. Note white paper to be brought into position between the glasses, also the rubber pads and wrist guards and the method of lifting the sheet.



Fig. 1A.—PACKING LARGE SHEETS OF PLATE GLASS

After placing the glass in the case, showing a bedding of straw being inserted all round the glass prior to nailing on the lid. Note that plate glass is packed in a close-boarded case and not in a crate.



Fig. 2.—THIS SHOWS THE PACKING OF MIRRORS
Placing mirror on damp-proof paper with bedding of straw beneath.



Fig. 2A.—PACKING MIRRORS

Mirror completely wrapped in damp-proof paper. Straw packed firmly all round and finally on the top before lid is affixed. Note the wooden spatula used to assist the packing. Boxes should always be stored on end, as in Fig. 1.

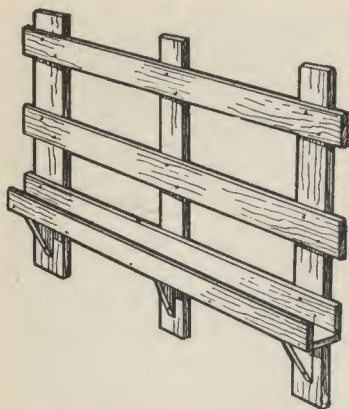


Fig. 3.—WHEN CUT TO GLAZING SIZES, GLASS IS SENT ON TO THE JOB IN A FRAIL AS SHOWN

The glass is tied into the frame by cord or webbing.

Store on Edge

For this reason, glass is best if stored on edge, in properly constructed racks, and each sheet, when withdrawn for cutting or any other purpose, should be gently slid out until it can be lifted by one vertical edge and the bottom.

Keep the sheet upright as it is being lifted, so that the weight is thrown on to the hands, and not transversely across the material itself. It is liable to slip through the hands if held at opposite sides of the sheet, and bad cuts often result from such handling. The wise craftsman will handle all large pieces with rubber pads to prevent the sheets from slipping.

How Glass is Packed

Manufacturers invariably dispatch glass in crates of stock sizes, each crate containing some hundreds of superficial feet. It is a peculiarity of the material that sheets of it have the property of adhering by molecular cohesion—that is, they “lie close” together, and several sheets thus have sufficient resistance to withstand a severe blow. Thus, in a crate, the edges of the glass are more carefully protected than the sides—generally by means of straw; but this does not mean that the crate can be bumped about without its contents being damaged.

Handling Crates of Glass

No crate should be “dropped off” a lorry, but carefully lifted down or lowered by means of an inclined board or ladder.

It is safer to move crates by means of rollers than by lifting them—even when their weight and size do not make this imperative.

Holder for Glazing Sizes,

When cut to glazing sizes, glass is sent out on to the job in a frail, as in Fig. 3. It may be small, and suitable for a few pieces of thin sheet, or it may be large enough to take large sheets of plate glass; it may be fitted with slings for carrying on the back up ladders, or

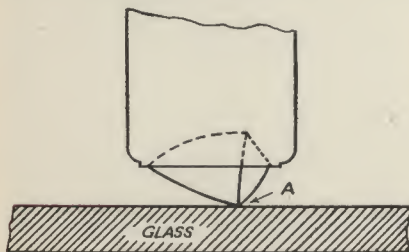


Fig. 4.—DIAMOND CUTTING GLASS

Actual cutting is mostly done by part of diamond (shown enlarged) at “A.”



Fig. 5.—LIFTING A LARGE SHEET OF PLATE

The actual lifting is done by means of leather slings; the stays with handles on them are to steady the sheet, so as to prevent it from falling owing to its weight and to ensure its being kept rigid, so that it does not break of its own weight.

with heavier slings for hoisting—no matter its size or the attachments, its construction and function remain the same. Naturally, the glass is tied on to the frame by cord or webbing, and if the sheet be unusually large for its weight or thickness, slings of webbing may be provided for the convenience of the craftsmen who have to fit it.

GLASS CUTTING

To-day, glass is cut with the aid of a diamond or a hardened steel wheel; but, until barely a century ago, the only methods available were primitive in comparison. The glaziers of former days scratched their comparatively soft glass with a hardened steel point, or employed a hot iron to cut the sheet. Even to-day, some thin sheet can be cut with the glass-hard end of an old file, while it is possible to cut glass with



Fig. 6.—FITTING THE SHEET

The stays are used, as before, when the glass arrives on the job; but the leather slings are replaced by lengths of webbing, which are cut off when the sheet is finally fitted.



Fig. 7.—FITTING—SECOND STAGE

The glass ready to be lifted into the glazing opening. The man on the step-ladder takes the place of the stays, besides attending to the fitting of the glass in the top rebate.

a hot iron, applying considerable pressure on one edge until the glass breaks, and then, with equally heavy pressure, leading the crack over the glass with the iron, which must be kept almost red hot. But these are expedients that to-day may be useful once or so in a lifetime.

How the Diamond or Wheel Cuts the Glass

The diamond and the wheel cutter are now in universal use. Both these instruments act in the same manner; that is, they act first as burnishers, compressing particles of glass, which particles then act as tiny wedges, separating the glass in the direction in which the diamond or wheel may be drawn. Note that there is a difference between the cut made by these instruments—which penetrate well into the thickness in the glass—and the rough, superficial groove ploughed out by any scratching instrument, such as the end of a file.

Diamonds Used

Diamonds used in glass-cutting are always natural stones, being uncut and unpolished because the natural skin of the diamond and the edges of the natural crystal are far harder and far sharper than anything that cutting and polishing can achieve. It is generally recognised that



Fig. 8.—It's in! AND ALL IS READY FOR THE FIXING OF THE GLAZING BEADS
This gives a good view of the lengths of webbing used to lift the sheet.



Fig. 9.—CUTTING A LARGE SQUARE OF POLISHED PLATE GLASS (1)
Marking off the size for cutting, using glazier's lath and diamond tool.



Fig. 10.—CUTTING A LARGE SQUARE OF POLISHED PLATE GLASS (2)

The assistants hold the straight-edge steady, while the cut is made with a diamond.
Notice the position of the operator, and how the diamond is held.



Fig. 11.—BREAKING OFF THE WASTE

The waste piece is gripped tightly in both hands—note the pads—and a sharp jerk is sufficient.

the stone whose edges are exactly at right angles cuts glass best, and that the actual cutting is done for the most part by that portion of the edge near to the point of intersection ("A" in Fig. 4).

Diamonds are sold in various sizes, at prices varying from under twenty shillings—for a small diamond that will cut thin sheet only—to several pounds—a tool suitable for the thickest of polished plate. A good diamond should be capable of being reset four times, at a cost of a few shillings per setting, whether it be a large or small diamond.

Mounting a Diamond

Diamonds are mounted in brass blocks, fitted to handles, the block being given a swivel action by means of a screw in it that works in a slot in the stem. This permits the block some "play," and thus automatically keeps the cutting edge parallel with the straight-edge or pattern, so ensuring that the diamond will cut without being damaged when held at the correct slope and when (if necessary) canted either to right or left.

Using the Diamond Tool

Every diamond varies in these two latter particulars, and these may vary when the diamond is reset; and it is vitally important for the

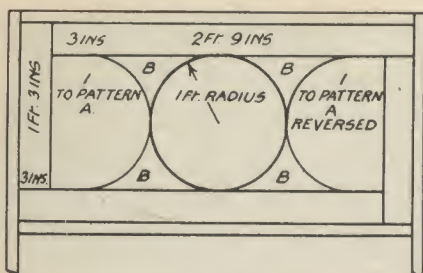


Fig. 12.—EXAMPLE OF GLAZIER'S DRAUGHT FOR CUTTING TO MEASURED SIZES

Draught No. 1. Job: Fanlight of entrance door. Glass: 21-oz. drawn sheet. Cutting list: 2-2 ft. 9 in. by 3 in.; 2-1 ft. 3 in. by 3 in.; 1 circle, 6-in. radius; 1 as pattern A; 1 as pattern A reversed; 2 as pattern B; 2 as pattern B reversed. Allow for fitting.

Do not bear on a diamond with any great pressure while cutting, or the edge will be damaged; for the same reason, do not halt in the middle of a cut and—

most important of all, though it is mainly a beginner's fault—never go back over the cut.

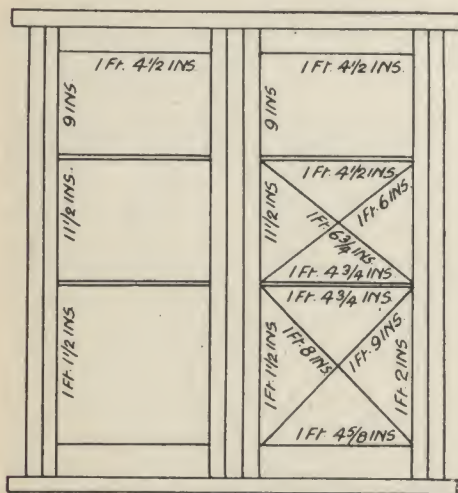


Fig. 12A.—ANOTHER EXAMPLE OF GLAZIER'S DRAUGHT

Draught No. 2. Job: Two-light casement, 1st floor (back). Glass: 21-oz. reeded. Cutting list: 2-1 ft. 4 1/2 in. by 9 in.; 1-1 ft. 4 1/2 in. by 11 1/2 in.; 1-1 ft. 4 1/2 in. by 1 ft. 1 1/2 in.; 2 to special dimensions shown. Allow for fitting.

craftsman to discover and memorise the correct slope and cant of the particular diamond he is using, else he will fail to cut the glass and will ruin the edge of the diamond into the bargain.

Pressure Required when Cutting

Although it is often stated, it is not correct to say that diamonds require no pressure, since the tool must be held firmly on to the glass and be drawn along with a steady, unhesitating movement, keeping the same pressure—although it be little—throughout the stroke.

Wheel Cutters

Wheel cutters are sold in numerous patterns, at various prices, and a pattern should be chosen for which spare wheels in bags can be obtained; for, although a wheel will last for a prodigious time in skilled hands, it will not do anything approaching the amount of cutting that a diamond will. The little square notches in the body or handle of the wheel cutter should be ignored: they are a survival of the old-fashioned glazier's iron, whose use has been replaced to far better effect by the use of pliers.

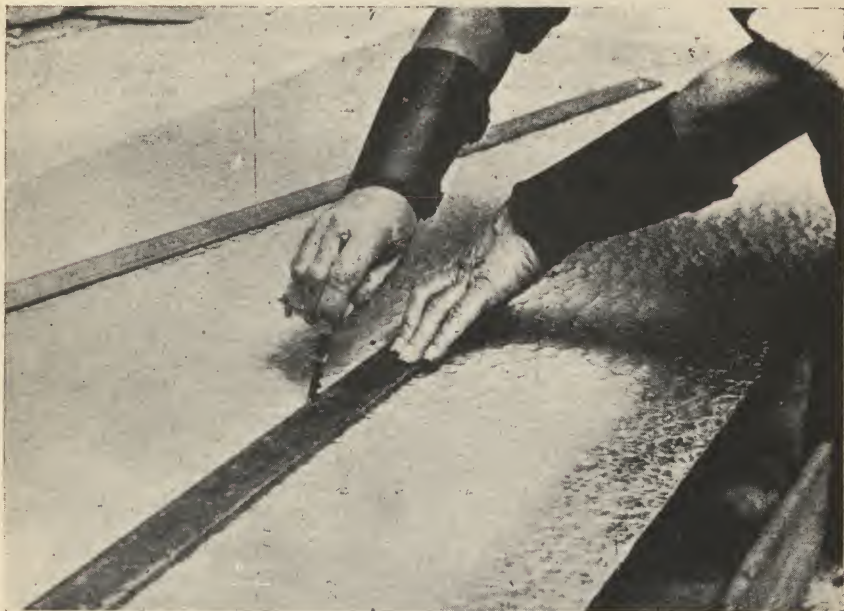


Fig. 13.—CUTTING FIGURED ROLLED GLASS

The cut is being made with a wheel on the smooth side of the glass. Notice how to hold the cutter—between the first and second fingers, with the thumb at the back. Note the glazier's lath just behind the operative's hand.

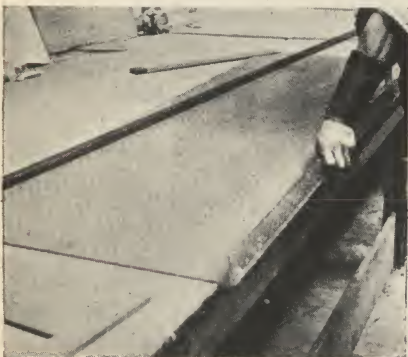


Fig. 14.—CUTTING $\frac{1}{4}$ -IN. WIRED ROUGH-CAST GLASS

The waste is broken in the usual manner.



Fig. 14A.—CUTTING WIRED GLASS—SECOND STAGE

Note the waste piece bent back over the side of the table, necessary to sever the wire mesh.

TABLE 1.—SAFE GLAZING SIZES OF GLASS (FOR RECTANGLES ONLY)

Type	Weight per sq. ft.	Thickness	Manufactured Size	Safe Glazing Size
CROWN GLASS . .	Varies greatly	Varies greatly	Sheets, 12 × 10 in. and 14 × 12 in.; "Tables" up to 20 × 16 in. (British) and 4 ft. square (Foreign).	24 × 24 in.
DRAWN SHEET GLASS.	15 oz.	$\frac{3}{16}$ in.	60 × 40 in.	24 × 24 in.
	21 oz.	$\frac{7}{16}$ in.	81 × 42 in. or 65 × 50 in.	30 × 30 in.
	26 oz.	$\frac{1}{2}$ in.	81 × 45 in. or 70 × 51 in.	35 × 35 in.
	32 oz.	$\frac{5}{8}$ in.	74 × 39 in. or 58 × 50 in.	40 × 40 in.
"HEAVY DRAWN" .	42 oz.	$\frac{3}{16}$ in.	62 × 35 in. or 54 × 41 in.	Calculate as for plate glass.
	3 lb.	$\frac{1}{4}$ in. bare	160 × 60 in.	
	3½ lb.	$\frac{1}{4}$ in.	160 × 80 in.	
PLATE GLASS (All Main Varieties)	2 lb.	$\frac{1}{8}$ in.	90 × 40 in.	Formula for calculation: $\frac{4ft.^3}{p}, \text{ when}$ $t = \text{thickness of glass,}$ $f = \text{maximum stress permissible.}$ $p = \text{wind pressure.}$
	2½ lb.	$\frac{3}{16}$ in.	110 × 72 in.	
	3½ lb.	$\frac{1}{4}$ in.	165 × 110 in.	
	5½ lb.	$\frac{5}{16}$ in.	280 × 130 in.	
	7 lb.	$\frac{3}{8}$ in.	180 × 120 in.	
	8½ lb.	$\frac{7}{16}$ in.	132 × 114 in.	
	10½ lb.	$\frac{7}{8}$ in.	120 × 100 in.	
	12½ lb.	$\frac{7}{8}$ in.	110 × 96 in.	
	14 lb.	1 in.	110 × 96 in.	
	17½ lb.	1½ in.	108 × 72 in.	

Using the Wheel Cutter

Almost all the above cautions are applicable to the wheel cutter, which, far from being an amateur's tool, is in general use among a large number of professional glaziers who deal exclusively with sheet glass. Of course, it is possible to cut plate with a wheel, but generally the cut is not sufficiently deep to ensure any certainty of a clean fracture.

Unlike a diamond, the wheel cutter should be held vertically, and some little pressure must be applied—although, here again, too heavy pressure converts the cut into a scratch and blunts the wheel.

The Glazier's Bench

The glazier's bench, besides being rigid and of sufficient size, is padded with a layer of felt and covered with baize in order to prevent the breakage of glass during the process of cutting. In an emergency any level surface covered with whole newspapers or a couple of sacks will serve.

Glazier's Lath and T-Square

Glass is cut to size with the aid of a glazier's lath (a rule, from 24 to 60 in. long, graduated either in inches from both ends or in inches and

feet from one end only) and a glazier's T-square, similarly graduated and having, like the lath, parallel sides to its blade.

Marking Out

The requisite width is ascertained by the lath and the glass marked with the cutter, making sufficient allowance for the stock of the diamond or wheel cutter.

Cutting Plain Glass

Glass is always cut from top to bottom of the sheet, so that the diamond or wheel is drawn towards the operative, and the sheet is cut right through, from edge to edge, broken as described below, turned round on the bench and then cut to the requisite length in a similar fashion. It is useless to attempt to cut a small square from the corner of a large sheet, since breakage would be inevitable; the sheet must be cut through from edge to edge and broken before the second cut is made. The T-square is generally used with the diamond, the stock of the square being at the head of the glass.

Cutting Circles, Ovals, and Curves

Circles, ovals, and other curves are often cut with a compass diamond. This tool possesses a special attachment into which the diamond is fitted: but it is safer to cut all curved figures to templates of plywood or cardboard, although paper patterns may be used if stuck on to the glass and carefully traced round with a diamond.

Separating Glass after Cutting

Normally, when glass has been cut with a diamond, it is separated as follows. The operative should grip the glass at the edge on each side of the diamond-cut; with the thumb of each hand on the top surface and the clenched fingers of each hand beneath. Then, gripping tightly, the hands should be jerked suddenly in an upwards and outwards direction, when the glass will separate at the cut, evenly and cleanly. In this way considerable force may be applied without the risk of cutting the hands.

Separating Thick Glass

When any difficulty is experienced with an extra thick or tough piece of glass, it may be necessary to bring the cut to the edge of the bench, place a straight-edge or piece of board along it and to press down firmly on this while an assistant breaks the glass by bending the over-lapping piece downwards.

Nipping off a Narrow Strip

When the strip left at one side of the cut is not wide enough to grip with the hands, pliers are used to snap it off. These are pliers whose top

edges only come in contact with the glass, and they are made in varying widths.

They are also used extensively in shaping pieces of glass for stained, painted, and leaded work, where owing to small sharp curves and re-entrant angles, the glass cannot be broken in the ordinary way after cutting with diamond or wheel.

The secret is to break off less than $\frac{1}{16}$ in. at a time and not to hurry the operation. Do not allow the splinters to fall on the bench.

For nipping off a strip on long plate glass the cutter may use grozers—a tool like long curling irons—going along the edge of the glass lengthwise.

Cutting Fancy Glasses

Fluted and reeded sheet and plate, with embossed plate and similar fancy glasses, have one side patterned and the other plain. Naturally, the glass is always cut on the plain side; but it should be remembered that this plain side is always fitted outwards, as is the convex side of crown glass.

Method of Cutting to Measured Sizes

This is only one reason why, wherever possible, the old-fashioned "glazier's draught" (a rough-dimensioned sketch of the openings to be glazed) should be made. It is not only necessary in order that fancy glasses may be fitted "right side out," but it is also advisable in the case of square sashes and casements, especially on repair work. These old frames are often out of square, while cheap new joinery is equally subject to this defect. In addition to the length and breadth of panes, the diagonals should be measured; and if there be any variation between these two latter, this should be entered on the draught. It is surprising how much waste of time and of glass this simple procedure will prevent.

Allowance for Expansion

When cutting to measured sizes, deduct no more than $\frac{1}{16}$ in. from length and breadth for new work, and up to $\frac{1}{8}$ in. for repair work; remembering also to groze off the corners of the sheet in this latter instance. These allowances for irregularities in the frames should not be exceeded, else the strength of the pane is impaired, and large, unsightly top-putties will be necessary. Yet some allowance for expansion must always be made.

One other Measuring Hint

In measuring for glazing, it is often impossible, especially on old work, to measure the exact size of the glazing-opening: but there is no need to wait for scaffolding or for hacking-out before measuring. In all sashbars, the rebate for glazing is the same width as the bevel or moulding

TABLE 2.—TYPES OF GLASS AND THEIR USES

Type	Uses
SPUN GLASS— Crown Glass (clear) . . .	In restoration work : in small panes in wooden sashes or in leaded lights.
BLOWN GLASS— Clear Sheet	General glazing in windows, etc., now being superseded by drawn sheet (clear), q.v.
Muffled Sheet, Sanded Sheet, Cathedral Sheet, Ambietti, Norman Slab, Specky Sheet, Reamy Sheet.	Fancy varieties of blown or "cylinder" glass, obtainable in clear and coloured varieties. Used for decorative lights, restoration of antique work, and largely in high-class leaded and painted lights.
DRAWN SHEET GLASS— Clear Sheet	General glazing in windows, doors, etc. This and "Heavy Drawn" (<i>see Infra</i>) are made in the following qualities: <i>Firsts</i> , for cabinet work; <i>Seconds</i> , for picture framing and glazing; <i>Thirds</i> , for houses, schools, and offices; <i>Fourths</i> , for general glazing, and <i>Horticultural</i> , for greenhouses, garden lights, etc.
Heavy Drawn	As a substitute for plate glass in cheap work.
Fluted Drawn	For bathrooms, lavatories, and similar positions where obscured glass is needed; much used, in lighter weights, for office windows.
PLATE GLASS— Polished Plate	High-class glazing in windows, general shop-front glazing; table tops, shelves, etc.; cabin and porthole lights; deck and floor lights. $\frac{1}{8}$ to $\frac{1}{16}$ in., for small panes and leaded lights; $\frac{1}{4}$ in., for general glazing, table-tops, etc.; $\frac{3}{8}$ in., for large shop fronts, long shelves, etc.; $\frac{1}{2}$ to $\frac{3}{4}$ in., for ships' saloon windows, operating tables, etc.; thicker varieties for cabin portholes, floor and deck lights.
Rough Plate, Rolled Sheet, Fluted Rolled, Rough Cast, Double Rolled Cast	Roofing glasses.
Figured Rolled	Obtainable in clear and a large number of colours and a large variety of patterns in many divisions of non-formed, semi-formed, formal and diffusing patterns. Used as a substitute for leaded work, and in all positions where patterned or coloured glass is required.
Wired Polished, Wired Rough Cast, Wired Rolled, Wired Figured Rolled	For all situations where there is risk of frequent breakage. Identical, except for wiring patterns, with the same varieties of unwired plate glass.
Toughened Plate	From $\frac{1}{8}$ in. upwards; used where there is very great risk of breakage. Five times stronger than plate of equivalent thickness. See also "Safety Glass."
MISCELLANEOUS— Opal and Coloured Opal Glass	For lining of walls, ceilings, etc., as a substitute for marble. Obtainable in a large range of self and variegated colours, (N.B.—Rough-cast double rolled and plain rolled plate can be obtained in the same range of colours.)
Safety Glass	Thin sheets of glass interleaved with celluloid. Used for motor and aeroplane windcreens and some small industrial glazing jobs where freedom from flying splinters and frequent breakage is desired.
Pressed Glass	Decorative panels, pavement lights, and glass tiles.
Extra White Glass	For artists' studios, colour matching, operating theatres, etc.
Ultra-violet Glass	Permits the passage of ultra-violet rays. Used in clinics, schools, and in some hospitals and private houses, for reasons of health.
Heat-excluding Glass	Used in refrigerating work.
Colour-protecting Glass	Used to obviate the bleaching effect of the sun's rays in art galleries, etc.

on the bottom of the glazing bars, and thus exact glazing-size can be obtained by measuring from outside member to outside member of the mouldings or bevels on the two bars.

DRILLING AND GRINDING

As a general rule, these two operations are carried out by machinery, and best results are obtained in this way.

Drilling

Butt plate or sheet glass can be drilled with a slow-speed metal drill, ground to a flat bevel and fed with a mixture of fine emery powder and turpentine. Holes larger than $\frac{1}{4}$ in. can be drilled with a piece of brass tube, used as a drill and fed with emery powder and turps as before. To-day, however, most tool manufacturers supply sets of special drills for this purpose, and when a large amount of drilling is undertaken these will pay for their cost in the time saved by their use.

Grinding and Polishing

Similarly, grinding and polishing are operations that are better and more speedily achieved by the machine, but sharp edges of plate or sheet glass can be ground off on an ordinary emery-wheel. Such stones may also be used to impart a permanently frosted surface either to plate or sheet—in which latter case, lubrication with fine sharp sand will assist the process.

Warning—Safety Glass and Toughened Plate

All the foregoing applies to all types of glass except "safety glass" and "toughened plate." These must be ordered in exact glazing sizes from the manufacturers, and must neither be cut nor grozed. A touch of the diamond is sufficient to make toughened plate fly to splinters, with a loud report; while, because "safety glass" is interleaved with celluloid, cutting will affect one surface only, and breaking will ruin the sheet. For the same reason, toughened glass and "safety glass" must not be grozed; and it is wise, when fitting, to avoid the use of sprigs.

Chapter IV

SASH GLAZING



Fig. 1.—PUTTY GLAZING WOODEN SASHES—
FIRST OPERATION

Feeding in bedding putty in rebate underneath putty knife.

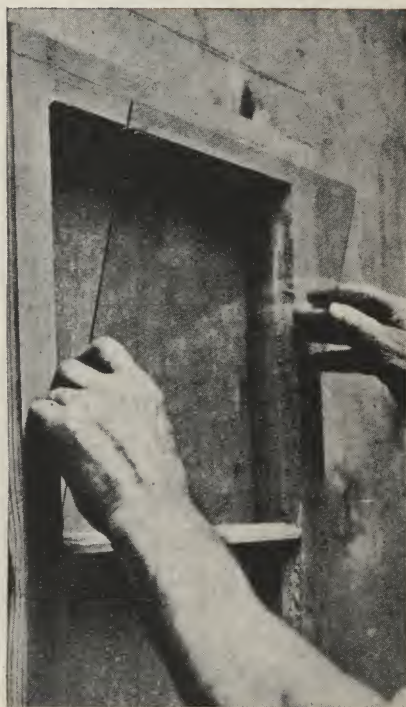


Fig. 2.—PUTTY GLAZING WOODEN SASHES—
SECOND OPERATION

Inserting square of glass, pressing it forward all round the rebate.

PUTTY is usually stocked in 1-cwt. iron kegs, and in handling and cartage the linseed oil has a tendency to come to the top of the keg, leaving the putty at the bottom a little harder. The practice is for a "putty boy" to knock up the putty, making it easy for the glazier to "run the putty" on to the sash.

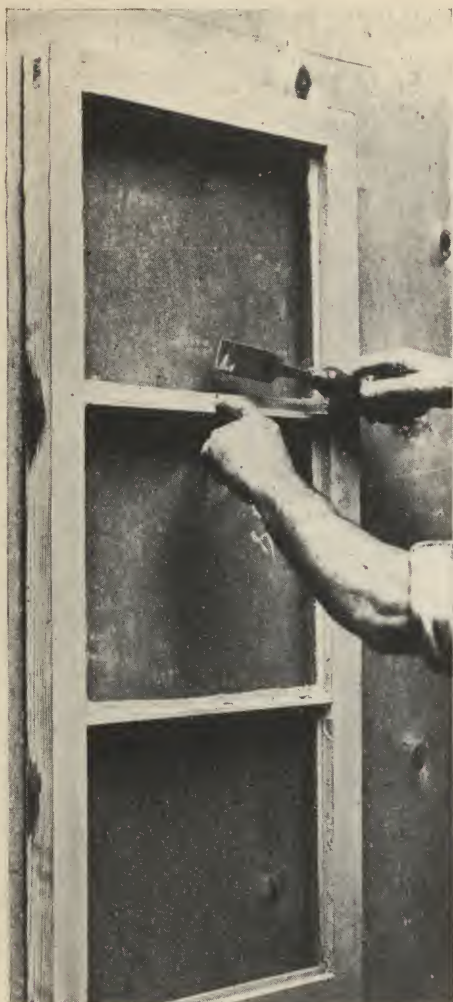


Fig. 3.—THIRD OPERATION

After the glass is well bedded it is held by brads, as shown.



Fig. 4.—FOURTH OPERATION

Running in the front putty and making bevel with putty knife.

The glass is generally cut to the required size and a quantity of squares stacked ready for the glazier.

Running Putty in Rebate

A handful of putty is held in the left hand and fed underneath the



Fig. 5.—FINAL OPERATION

Cutting off the overflow of bedding putty on other side of sash.



Fig. 6.—PUTTY GLAZING METAL CASEMENTS

Showing spring clip which takes the place of the brads used with wooden sashes. One end of spring is inserted in the hole in casement side, and other end presses upon the glass, the tension holding glass in position.



Fig. 7.—PUTTY GLAZING METAL CASEMENTS—FINAL OPERATION

This shows the puttying in, the clip being completely covered. The other operations are similar to puttying wood sashes.

putty knife in the right hand of the glazier, who runs the putty in the rebate (Fig. 1), called the "bedding putty."

Inserting Glass

He next takes a square of glass and inserts (Fig. 2) it in the sash and presses it forward all round the rebate. This causes the bedding putty to overflow to the other side of the sash leaving sufficient putty to act as a bed for the glass, which is next bradded (Fig. 3).

Bevelling Front Putty

The glazier then with his putty knife runs the "front putty" (Fig. 4) evenly bevelled.

Stripping Off Back Putty

The sash is next turned to the other side, and the overflow of the bedding putty is stripped off, called "cutting off or stripping the overflow of the bedding putty" (known as the back putty), Fig. 5. The moulded side of the sash is called the back, because it is inside the room, and the bevel-puttied side is called the front, because the sash fronts to the outside. The illustrations show work on a small scale, so that the photographs could illustrate the operation clearly.

Glazing Metal Casements

Metal sashes are glazed in the same manner, but when ordinary putty is used it will not set quickly in the metal, and it is necessary to secure the glass by either wood or metal beads with tapped screws into holes already in the metal frames, or by using a spring clip as illustrated (Figs. 6 and 7), or by lead wire or pins passed through holes in the sash-bar of the metal frame. The more usual way is to use a quick-setting putty which is soon ready for the painter to follow on.

Chapter V

METAL SHOP FRONTS

CONSTRUCTION AND ERECTION

IN introducing this subject, it is most interesting to note that the fitting, assembly, and erection of metal shop fronts has become primarily the work of woodworkers. Those in this trade who have never done any work other than in wood should find this short chapter of an instructive nature. The metal is first drawn on the wood core. After this operation, the joiner or woodworker takes over, and cuts and assembles ready for fixing.

THE METALS USED

The metals most commonly used are in the following order :—

Bronze.

“Staybrite” (stainless steel).

Aluminium and other white-metal alloys are also used to an increasing extent.

Bronze and “Staybrite” have now become quite common in the shopfitting world.

Bronze

This is very popular because of its easy working in both assembly and fitting. With regard to the cost it is in fact no dearer than polished hardwood, and its durability is certainly of a high standard. If treated properly in its early stages after being fixed, it can be brought to a very rich shade of copper coinage colour, and so never gets that down-at-heel look a wood shop front does. It can also be kept bright, but this requires constant attention and cleaning.

“Staybrite” (Stainless Steel)

This is fast becoming a most popular metal for shopfitting, mainly because of its attractive appearance and its resistance against all weathers.

Many people will naturally think that this metal never requires attention. This is not quite true, as, in the case of stainless steel cutlery, it occasionally requires to be washed with warm water. Then it does not deteriorate in any way and keeps its original lustre.

SELECTION OF SECTIONS

Great care must be taken with this part of the work, as the indiscriminate selection of mouldings results in an imperfect job.

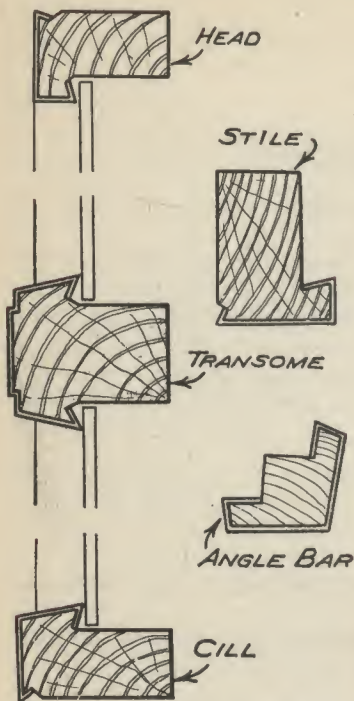


Fig. 1.—SECTIONS OF A SIMPLE METAL-FACED SHOP FRONT

Showing head or top rail, transom or intermediate rail, cill or bottom rail, stiles, and angle bar.

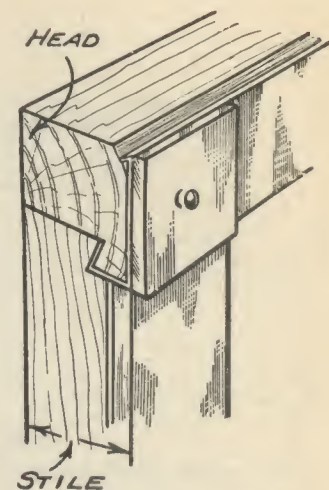


Fig. 2.—JOINT OF HEAD AND STILE COVERED WITH A FLAT PATERA



Fig. 3.—HAND-RAIL BOLT BEING INSERTED FOR BOLTING MITRED JOINT

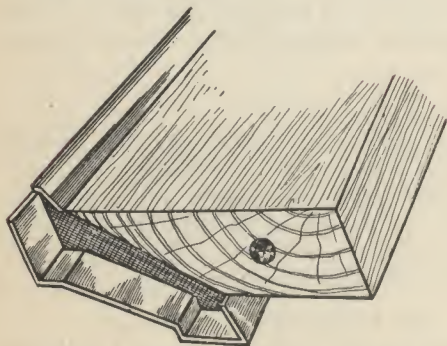
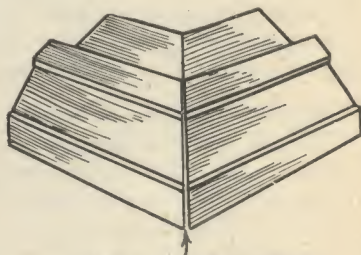


Fig. 4.—HOW WOOD IS CUT AWAY FOR SWEATING MITRED JOINT



METAL LEFT OPEN

Fig. 5.—HOW TO UNITE MITRE FOR WELDING EXTERNAL ANGLE

In this case the wood is not cut away, but the metal is allowed to remain slightly open.

Let us take a simple shop front, the sections of which consist of head or top rail, transom or intermediate rail, cill or bottom rail, stiles, and angle bars.

For Head and Stiles

The head and stiles are generally of the same section, but as the edge of all metal mouldings is slightly rounded, it is better to cover the intersections with a patera, and as modern shop fronts are very simple in design, small, flat, or slightly raised pateræ are most acceptable.

For Transom and Cills

The transom and cills should be of a bolder nature, and should master stiles and angles at all points. This need not apply in all cases, as it will be seen by the illustrations that designs of all kinds and architects' details can be meshed together.

Mouldings can be mitred so that true intersections can be obtained as satisfactorily as in wood.

CUTTING OF METAL

When the joiner takes over rods, mouldings, and all details, special care must be taken to see that the right lengths are cut. This is most essential, as in practice it has been found better to draw the mouldings in long lengths and so avoid the unnecessary wastage caused by having to allow at least 6 in. on every length drawn. This is to allow for the tongs of the draw-bench to be firmly fixed. Should several short lengths of a similar moulding be required, they are added together and drawn in one length.

The most suitable lengths used are between 12 and 14 ft.

Having checked all metal for the job, cutting is now proceeded with.

Mitred Joints—Cutting Bronze Metal

For a simple mitred joint an ordinary mitre cut can be made, though a saw suitable for metal must be used. In the case of bronze metal, the ordinary hand-saw is very serviceable and does not hurt the saw a great deal, though it requires constant sharpening.

The most serviceable tooth to use is about No. 10. It is much better, though, to get the specially tempered and sharpened metal hand-saw.

Cutting Stainless Steel with Hacksaw

With stainless steel it has been found that only the specially hardened and tempered hacksaws can be used. These are made only by Firths, and no others are really serviceable. This makes it more difficult for cutting and mitreing unless an extra-large hacksaw frame is used. Quite a perfect cut can be made best by the use of the ordinary mitre template.

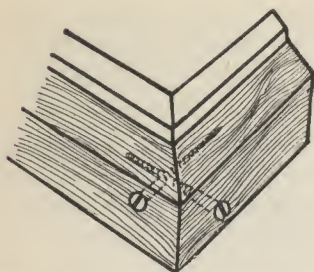


Fig. 6.—JOINTING INTERNAL ANGLE THAT WILL NOT BE SEEN IN FINISHED JOB

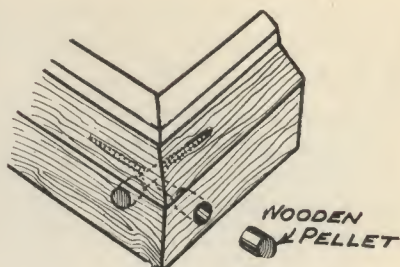


Fig. 7.—JOINTING INTERNAL ANGLE WHEN CORES WILL BE SEEN IN FINISHED JOB

Adjusting the Mitre

The cutting completed, it may be found necessary to touch up the rough edges of the metal, and also adjust any discrepancies in the mitre. This is done by filing. Here the mitre block can be conveniently used, but it will be found much better before doing so to apply a special facing so that no damage is done to the existing faces of the block itself.

The completed mitre will be as perfect as in wood.

Completing the Joint

While in wood, dowels or tongues can be used, we must now use hand-rail bolts. These are not foreign to wood joints, but not commonly used in ordinary mitres. Fig. 3 shows how to insert these. One nut of the bolt is circular and has slots for turning with a lever.

Making Sweated Joints

Before completing the mitreing by gluing and bolting, it is necessary to prepare for the following operation of sweating. For this purpose the wood must be cut away so that solder and small fillings of metal can be inserted. The binder, or some part of the metal invisible to the eye when fixed, is cut away, namely in cills—the under side; in transoms and head—the top (Fig. 4). This enables small particles of metal, about $\frac{1}{2}$ in. by $\frac{1}{4}$ in. to be dropped in together with solder. A great point to be noted here is that the wood being cut away from the back prevents any breaking of sweated joints owing to any dampness that may cause the wood to swell and so break the face of the joint. This might otherwise happen, especially in the cills of a shop front much exposed to the weather. The inside of the metal where the core is cut away must be cleaned so that the solder will run and unite, making a perfect joint. In the unhappy event of the fixer finding any defective joints or mitres in his job, it is a difficult matter for him to get over, and the best method is to



Fig. 7A.—CUTTING MITRE OF STAYBRITE WITH FIRTH'S HIGH-SPEED HACKSAW BLADE

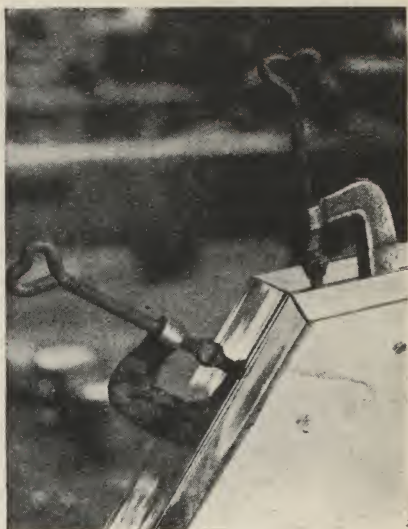


Fig. 7B.—CLAMPED MITRE OF TRANSOM, SHOWING GAP PRIOR TO WELDING
Gap allows for expansion.



Fig. 7C.—WELDING TRANSOM RAIL OF SHOP FRONT

cover up such defective joints with a patera, although it naturally follows that corresponding joints would have to be covered with similar pateræ.

The Welding Method

Another method of uniting angles is by welding. This has not been used until lately to any great extent, but is now becoming very popular, as the metal is really and truly united. It is not necessary in this case to cut the wood away, but rather to let the metal remain slightly open. This allows the flame to pass through and complete the joint.

If no space were left for this joint in the mitre, the metal when heated would expand and curl, and it would be impossible to make a good joint.

Care must be taken that the oxy-acetylene flame, being of such intense heat, does not thin out the metal too much, and also care must be taken not to burn the wood behind the metal, as this causes the metal to become springy on its core, and in a very short while to break and produce a bad joint.

These methods of jointing are carried throughout on all external angles.

Jointing Internal Angles

It is not the practice to sweat or weld these, nor is it necessary to use hand-rail bolts except in the case of very flat angles. They can be put together by the use of ordinary wood screws through the back of the cores. If these cores are seen in the finished job, it will be better to sink slightly and insert a wood pellet.

If the joints are made in the shop, it is important to fix stout rough wood braces to ensure that no movement is made whilst en route to the job, and, in fact, these braces should be left in position until ready for glazing.

Joints to Assemble on the Job

A given run of a shop front may be too extensive for complete assembling in the shop, owing to the difficulty of transport after. In this case leave the least obtrusive of the joints for final assembly on the job. It must be an internal angle that will not need sweating.

ERECTION OF SHOP FRONT

This chapter attempts to deal only with general joinery as it applies to metal work. We will now deal with the general assembly and fitting together of a metal shop front, taking as an example a small double-fronted shop. Details of this are as follows :—

Fascia.—Drawn metal surround with glazing fillets for face glazing.

Sunblind Box.—Complete with bronze metal lath and edgings.

Shop Front.—Consisting of head, transom, and cills, upright bars and tracery work above transom.

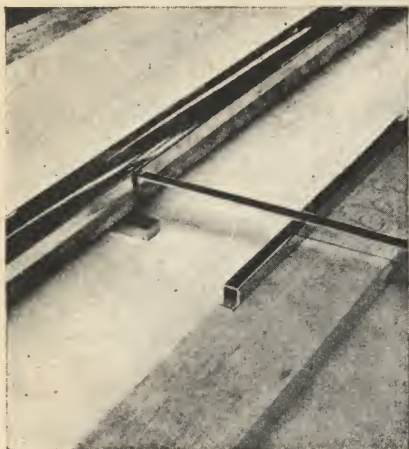


Fig. 7D.—TRACERY BARS
Showing tongue joint to transom and
halved joint to tracery bar.

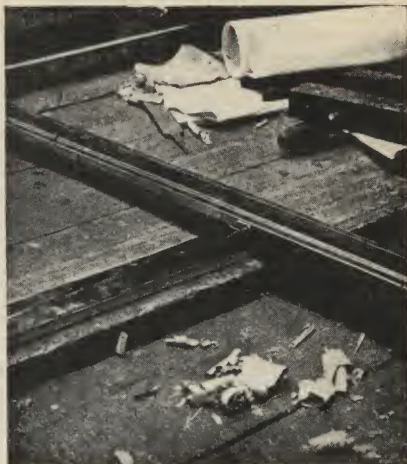


Fig. 7E.—TENONING INTO TRACERY BAR

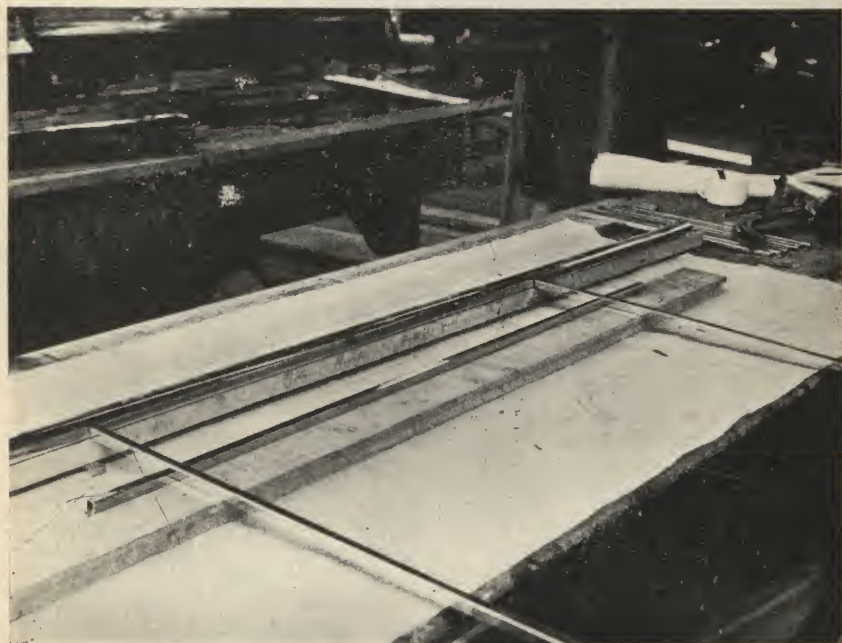


Fig. 7F.—TRACERY BARS TO TRANSOM COMPLETELY ASSEMBLED

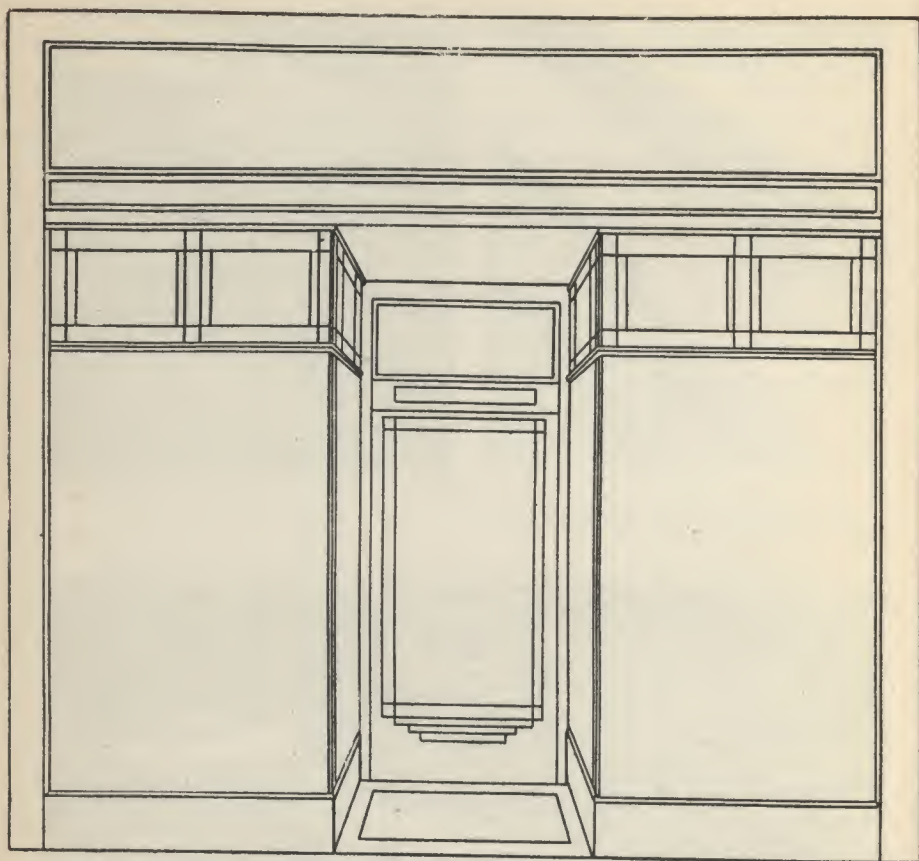


Fig. 8.—SMALL DOUBLE METAL-FRONTED SHOP, THE ERECTION OF WHICH IS DESCRIBED
IN THIS CHAPTER

How Metal Work is Shown on Setting-out Rod

To begin with, all metal work is denoted on setting-out rods by a double line and etched in either a yellow or red pencil.

Simple Assembly of Sashes

The cill is fitted up as before described, and the transom and head are fitted on top, working from the rebate, or glass, sizes, as it is most essential that no alteration should have to be made when a fixer is handling the job.

The mitreing and sweating completed, next fit the stiles and angle bars into their respective positions.

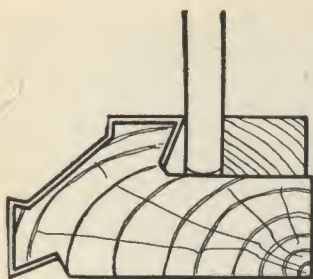


Fig. 9.—ALL METAL WORK IS SHOWN ON SETTING-OUT RODS BY A DOUBLE LINE

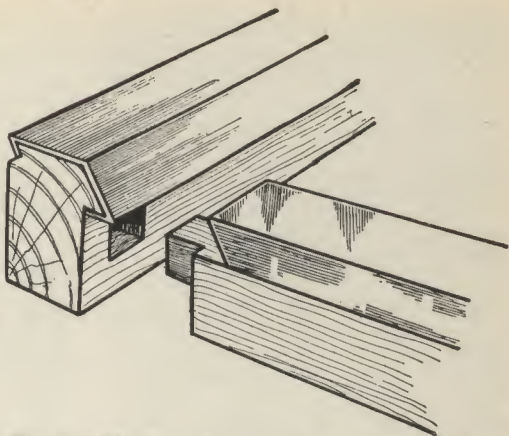


Fig. 11.—METHOD OF FITTING STILES AND BARS INTO CILL AND HEAD

Metal bar cut to fit neatly on metal rail, and wood cores cut to form stub tenon.

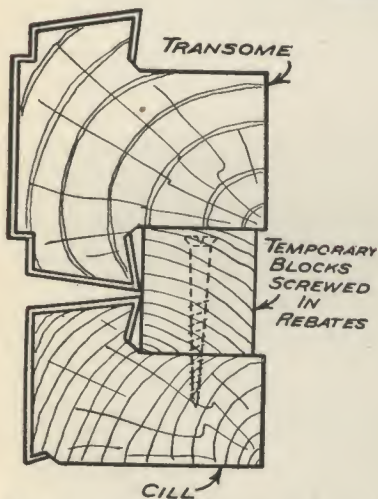


Fig. 10.—ASSEMBLY OF CILL, TRANSOM, AND HEAD WORKING FROM THE REBATE SIZES

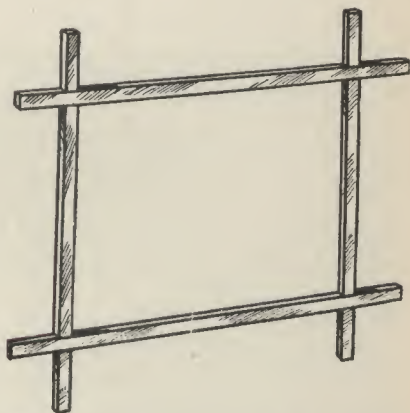


Fig. 12.—TUBULAR GRILLES FOR TRACERY WORK, AS MADE BY METAL WORKER

Fitting Stiles and Bars into Cill

To fit stiles and bars into cill, cut the metal bar to fit neatly on the metal rail, allowing the wood core to run on and so form a small stub tenon into the cill.

Cutting Metal to Form Tenon

When cutting, it is best to just cut through the metal and tap this off, so allowing easy working for the forming of the tenon.

In the small front we are describing, this entails stubbing into cill four stiles and two external angles.

Tenoning into Transom

Now take the height of glass and mark off the length of bar for tenoning into the transom. Care must be taken to see that the glass sizes again are strictly adhered to and due allowance made for glazing.

Fitting Bars into Head

The bar is tenoned in a similar manner as for the cill, and this is repeated again for the bars above transom and into head.

Cutting the Tracery Bars

Next cut the tracery bars. These can be made in several ways, the following two being most used.

Tube Tracery Work

The tube tracery work is fitted together by metal workers, who allow enough for fixing into the sashes. This enables the glass above transom to be in one sheet. It will be seen that the method of fixing these bars into the upper part of the sash is by allowing a thin portion of the metal to drop into the rebate and be fixed with a screw.

T-bar Tracery Work

This method is used a great deal, the only drawback being that the glass above the transom has to be fitted in several pieces. This makes a great deal of work for the fixer.

Generally, T-bars are of a small drawn section with the lay bars slightly deeper than the uprights, the reason being to avoid all slightly rounded edges making faulty intersections.

Halving Bars Together

The bars should be cut off to approximate lengths, both lay and upright, and marked for halving together.

A Caution as to Fitting

A point of care to be taken is to avoid getting the width of the metal too tight, otherwise when fitted together it will cause the tracery bars to be bowed and so cause breaking of glass.

Cutting and Assembling Grilles

The right size of grilles should now be taken and cut in a similar way for stiles in the general shop-front work, allowing the wood core to enter



Fig. 12A.—HAND-SCORING METAL BEFORE FOLDING IN MACHINE



Fig. 12B.—FOLDING METAL FOR ANGLE BAR



Fig. 12C.—FITTING FOLDED METAL ON TO WOODEN CORE



Fig. 12D.—METAL-FACED SHOP DOOR

This shows the method of fixing metal to the woodwork.



Fig. 12E.—METAL DOOR FRAME

Filing the welded joints.

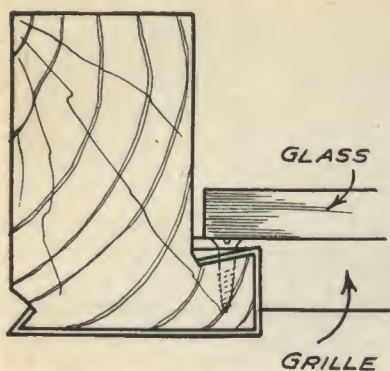


Fig. 13.—METHOD OF FIXING TUBULAR GRILLE TO STILES

This type of tracery work allows the glass above the transom to be used in one sheet.

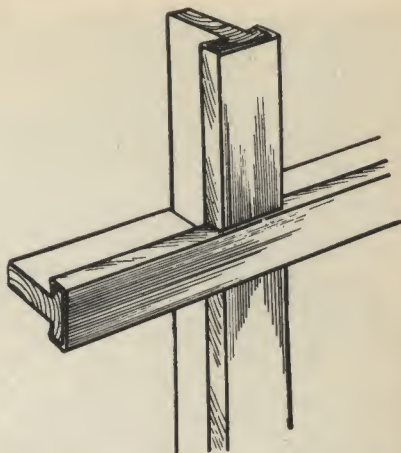


Fig. 14.—T-BAR TRACERY WORK WITH WOOD CORE

Note that the lay bar is slightly deeper than the upright.

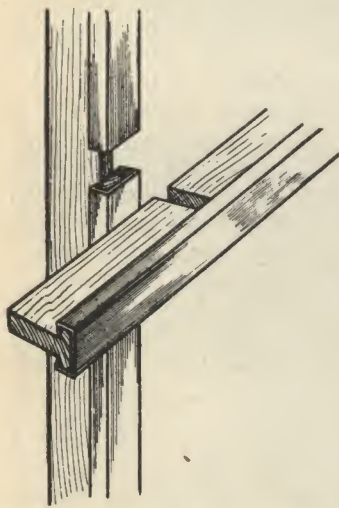


Fig. 15.—SHOWING HOW BARS OF T-BAR TRACERY ARE CUT FOR HALVING TOGETHER

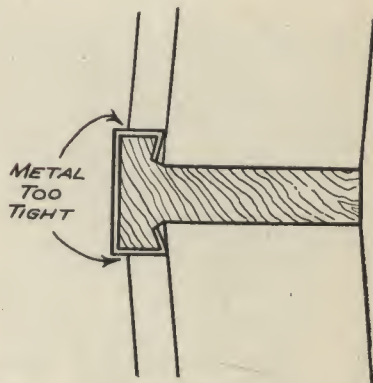


Fig. 16.—A FAULT IN T-BAR TRACERY THAT CAUSES BENDING OF BARS AND BREAKING OF GLASS

into the rebate and so allow for screwing. If necessary, they can be stubbed into the rebates, but by doing this the drawback is that the assembly of the upper part of the front must be done simultaneously

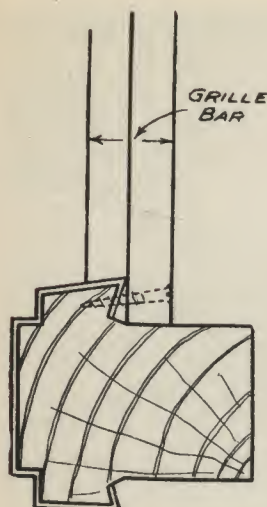


Fig. 17.—FITTING T-BAR TRACERY TO SASH

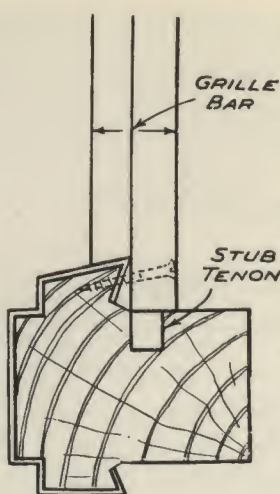


Fig. 18.—ANOTHER WAY OF FIXING T-BAR TRACERY

with the fixing of the grilles.

Erection of Upper Part of Front

We now come to the erection of the upper part of the front, which should, if possible, be done in the shop as it simplifies fixing considerably.

The stiles and angles should be glued into transom and screwed in the manner shown, the head being fixed in a like manner from the top. Good braces should be fixed so that no chance of

racking occurs in transit or while being fixed in position on the job.

This completes the general assembly of shop-front sashes, except in cases where fixing stiles are required. These can be prepared by the use of a drawn moulding or by metal applied by means of screws, which, of course, should not be seen when job is fixed.

In most cases fixing stiles are required, as sites are usually a little out of line and plumb, and so these make it possible to get a square erection of the front itself.

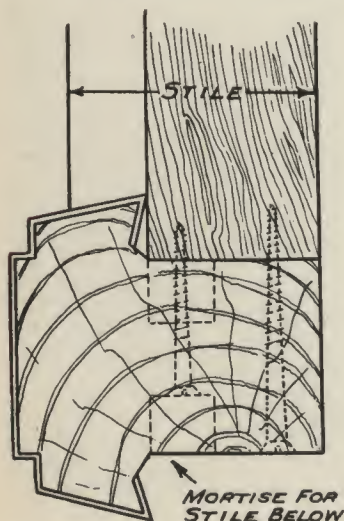


Fig. 19.—FITTING STILE TO TRANSOM

Fitting Blind Box

Fitting of the blind box is done similarly as for wood in general shop-fitting, except that the mouldings supplied are of metal. The box usually comprises bottom, back, top, and cheeks. We will assume that the blind box in this case is fixed under the fascia, and sections used. The cores of applied mouldings are grooved to be fixed to the



Fig. 19A.—METAL SHOP-DOOR HANDLE
Drilling with electric drill.



Fig. 19B.—SWEATING METAL SHOP-DOOR
HANDLE



Fig. 19C.—BLIND BOX, SHOWING ZINC
LINING TO MAKE IT WATERTIGHT

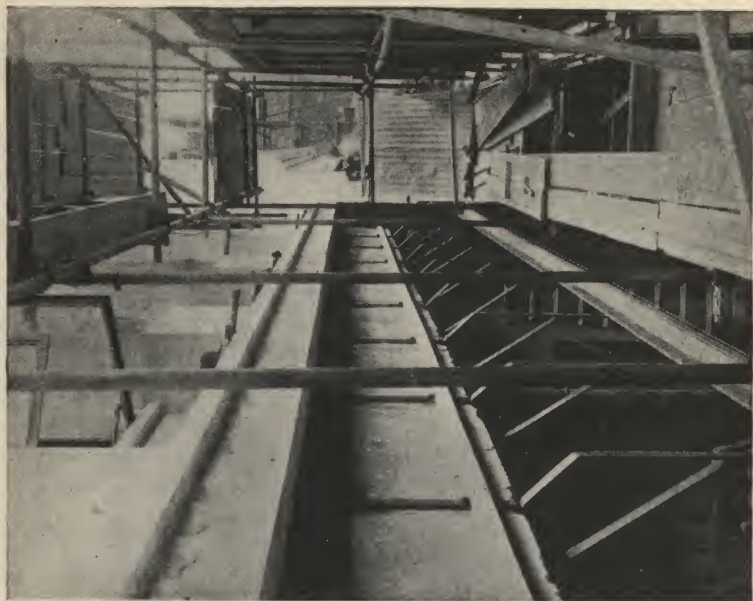


Fig. 19E.—ERECTING FASCIA
Angle irons and metal holder ready for fascia board.



Fig. 19D.—ERECTING FASCIA
Under side of shop front, showing angle irons fastened into concrete.

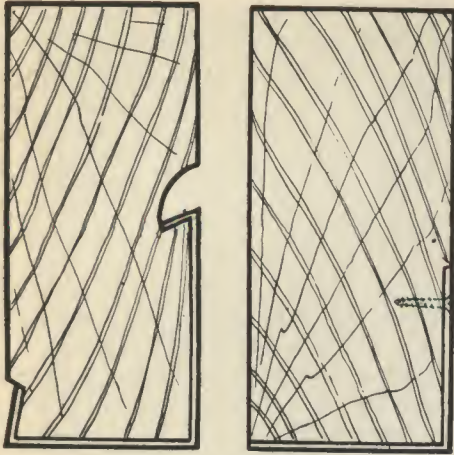


Fig. 20.—TYPES OF FIXING STILES
Showing a drawn section and an angle section screwed to wood stile.

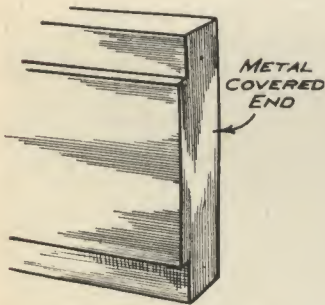
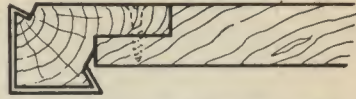


Fig. 22.—BLIND LATH COVERED WITH METAL AT END



ALTERNATIVE METHOD FOR
FIXING TOP MOULDING.

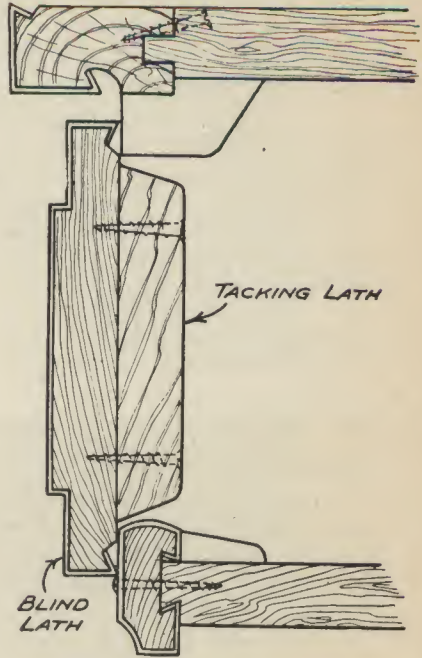


Fig. 21.—FITTING OF THE BLIND BOX
Showing an alternative method of
fixing the top moulding.

box. This is done after the moulding is drawn, as it tends to weaken the core if done beforehand, and so crush in the process of drawing the metal on to the cores.

The method of fixing the top mouldings to the box is by screwing from the back or the top. The bottom striking fillet is more often screwed from the front with raised head screws. If the blind roller is required of an extra-strong calibre or is exceptionally long, that is, say, 16 ft. or over,

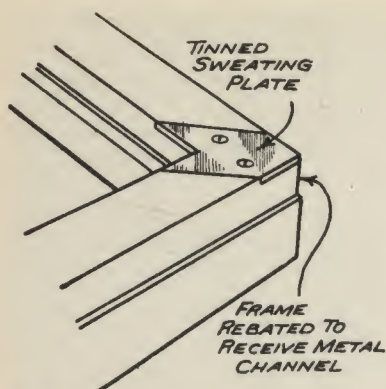


Fig. 23.—MAKING UP FASCIA BY APPLYING METAL TO FRAME

Note frame rebated to receive metal facing, and tinned sweating plate let in and screwed to corner of frame. See also Fig. 24.

it becomes necessary, in order not to have too large an opening, to do this, and so avoid the use of a large-section lath.

Type of Lath to Use

The reason for this is that metal laths are so heavy that when in use they are inclined to sag badly, and when pushed up do not fit into the box. Therefore, it is better to get the lightest section possible combined with strength.

The tacking fillet is screwed on the lath in the ordinary way, care being taken to give sufficient camber, so that when fixed it will drop to a normal straight line, and so obviate any sag afterwards.

Screwing on the Lath

Great care should be taken when screwing on this lath that the screws do not penetrate the wood and injure the back side of the metal. It is most difficult to get these marks out satisfactorily.

Proper Length to Cut Lath

The lath should be cut to length, due allowance being made for play, approximately $\frac{1}{4}$ in. either end, and stopped. For a good job the ends should be plated. The joiner first cuts the lath to the correct length, and inserts small sweating plates (already tinned), then the metal-worker fits in a piece of similar metal to the blind lath, sweats it into position, and polishes it off.

Methods of Fitting Fascia

Several distinct methods can be used. Wood frames can be made and angle-metal screwed on. Otherwise, drawn sections can be used on light back-frames. The choice, of course, is left to the designer of the fascia or to the shop-fitter's own fancy.

Applying to Wood Frames

If applied, the frame is made up complete in the usual manner with outer and inner edges rebated to take the angle or channel. A point to note here is that it is considerably cheaper, when applying metal, to screw on, if possible, and to keep the screws hidden.

The metal is cut as previously explained and fitted on to the frame,



Fig. 23B.—ERECTING FASCIA

This shows the fascia frame being hoisted into position on shop front.



Fig. 23A.—ERECTING FASCIA

Front of shop with shop-fitters' tubular scaffolding in position for erecting fascia.



Fig. 23c.—TIMBER FASCIA FRAME, SHOWING GENERAL CONSTRUCTION

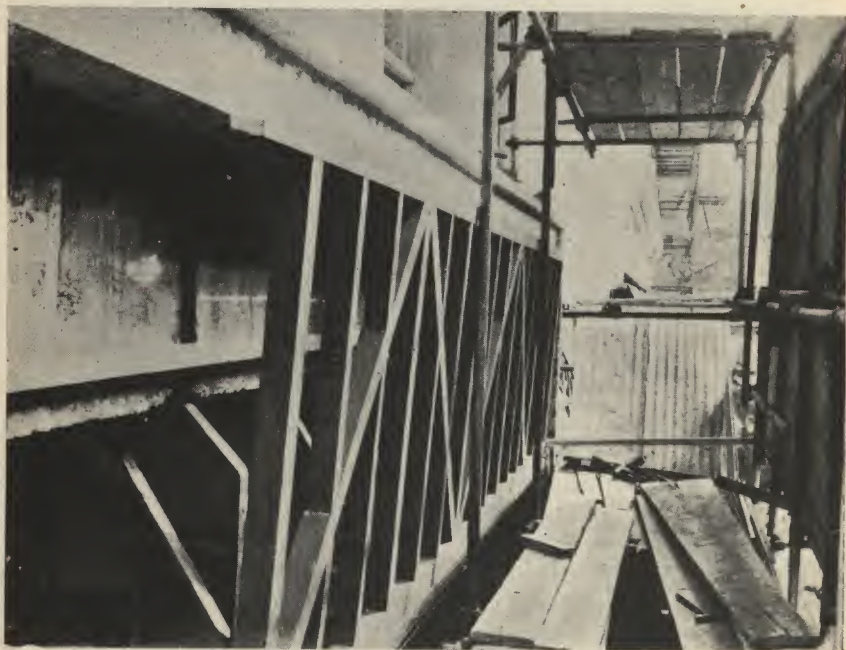
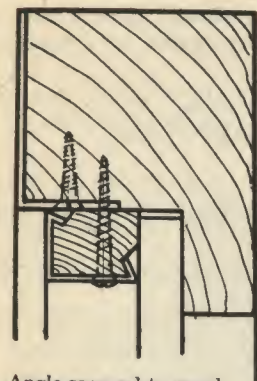
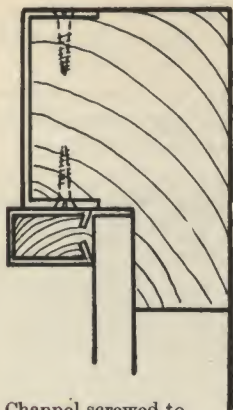


Fig. 23d.—FASCIA BOARD IN POSITION, HELD BY ANGLE IRONS



Angle screwed to wood frame.



Channel screwed to wood frame.

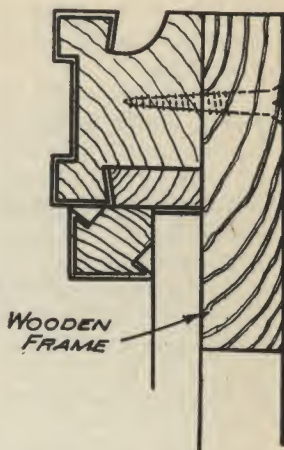


Fig. 25.—ANOTHER METHOD OF MAKING FASCIA

Drawn sections screwed on to light back frame.

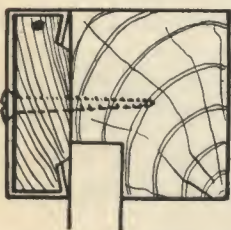
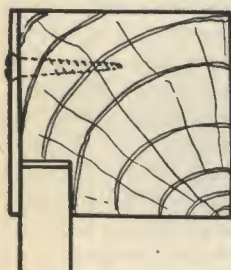
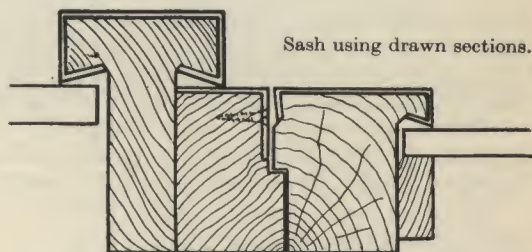
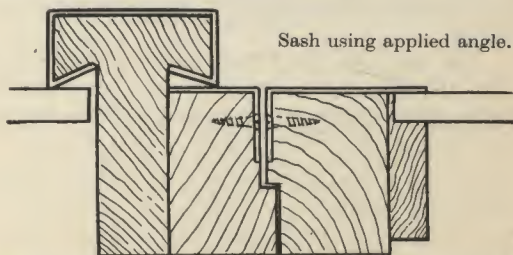


Fig. 26.—A THIRD AND CHEAPER METHOD OF MAKING FASCIA

Using either flat strips of metal or flat drawn mouldings screwed to wood frame.



Sash using drawn sections.



Sash using applied angle.

Fig. 27.—TWO METHODS OF DEALING WITH ACCESS SASHES

he only sweating being at the corners where a small tinned plate is let in. Then the metal is screwed on and a metal-worker completes by sweating or welding.

For glazing these frames in either cases a small, light metal section is used, which is cut, drilled, and mitred, and temporarily screwed into the frame with a few screws ready for fixing.

With drawn sections the process is similar to the preceding one, except that the mouldings are screwed to a light wood frame and are fixed from the back, using glazing beads.

A third and much cheaper method is to make up complete wood frames with rebates and screw flat metal on to the frames.

You will notice that here a choice can be made between the use of either a small flat drawn section or just sheet metal. With modern shopfitting this is generally done by joiners when fixing to allow for any small discrepancies that may occur on the site.

DEALING WITH ACCESS SASHES

In many of the larger arcade fronts or island sites these are necessary.

There are several methods of treating them, the two following being generally most acceptable to modern shopfitting.

A light wood frame is made with an inner door or sash. The outer frame is generally morticed or mitred together and covered with metal. The metal is exactly as for screwing on fascias. The metal is fixed by screws at the inner edge and is just sweated at the angle where necessary. In many cases the angle is inserted between two muntins or stiles in a front and does not show to any great extent. In this case, it would not really matter if it were left a clean mitre and not sweated at all. The inner frame or sash can be either of drawn section or angle metal applied.

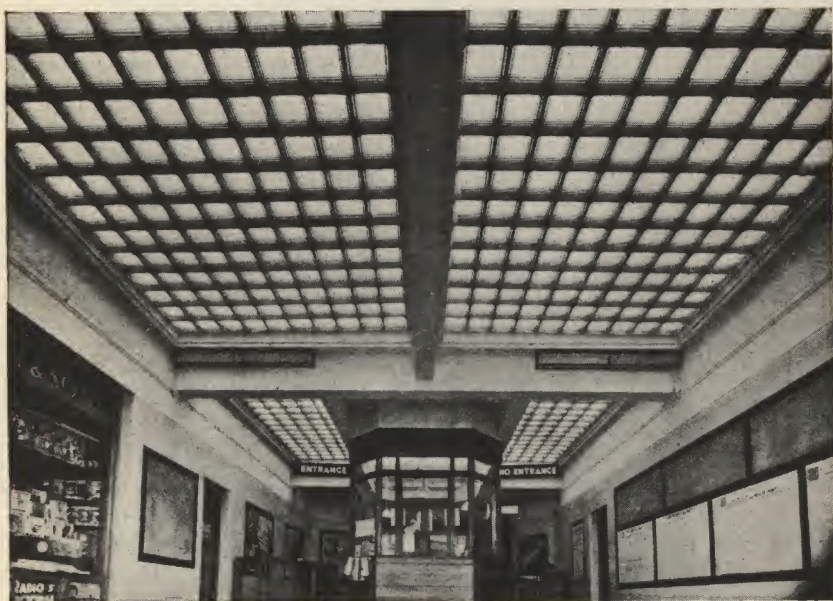
With a drawn section, the mouldings are mitred and screwed together from the outer edge, the screws being sunk sufficiently to allow small wood pellets or stopping to hide these when completed.

With the sash where the angle metal is applied the wood frame is morticed and tenoned together and fitted in the outer frame, due allowance being made for the thickness of metal, so that when applied it will not bind and cause a deal of unnecessary work in easing sash when finally fitting.

The best size for these access sashes is approximately 5 ft. 6 in. by 2 ft., though these may be varied according to the height of glass in the lower portion of front or to suit various trades.

Chapter VI

PRESSED AND MOULDED GLASS



By courtesy of J. A. King & Co. Ltd.

Fig. 1.—CONCRETE-AND-GLASS CEILING, RAYNES PARK STATION, SOUTHERN RAILWAY

The upper lenses built into the concrete, and lower fixed to under side of bars, giving an insulating air space between outer and inner glasses.

ALTHOUGH glass in its spun, blown, drawn, or rolled form has been employed for many years as a transparent material for filling windows and doors, the use of glass as a medium of construction is a comparatively recent innovation.

Pressed Glass

The invention of the process, however, whereby molten glass can be pressed and moulded into various shapes, definitely brings it into the ranks of those materials which perform constructive functions in modern buildings. Glass is widely employed to-day in two different functions. Structures such as the Crystal Palace (now destroyed by fire) or the Bauhaus at Dessau in Germany used vast areas of glass simply as window

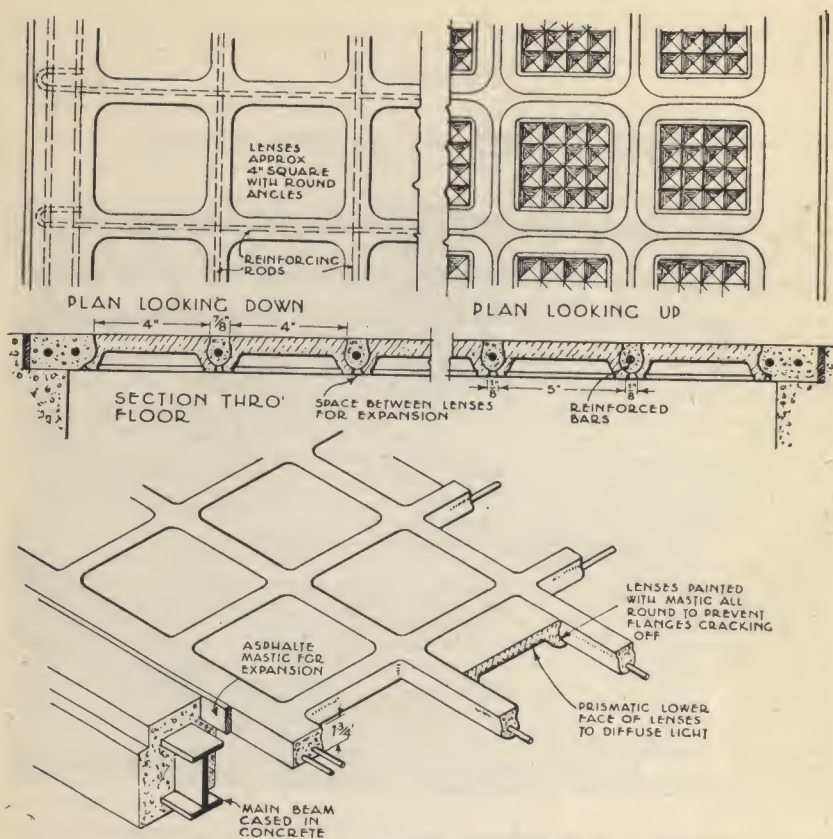


Fig. 2.—GLASS-AND-CONCRETE FLOOR, SHOWING MAIN BEAM

filling. The advance in design which makes the second function possible is in the steel-and-concrete structural support. It was the introduction of the reinforced-concrete pavement light filled with cast-glass lenses that really began the era of glass construction, for here both the materials perform structural functions. Modern glass floors and roofs are an extension of the principle of the pavement light.

Structural Principles

It is well known that in a reinforced-concrete floor slab the material is unstressed below the level of the reinforcing bars—all tension being taken up by the steel. Glass has a crushing strength equal to that of cement concrete; the glass prisms can therefore be manufactured coffer-shaped to take up the compressive strain alone, which means a thickness

of between 1 in. and $1\frac{1}{4}$ in., with flanges the full depth of the slab.

Completely Enclosed Reinforcing Bars

Between 1908 and 1910 a system of floor prisms was invented in Germany, having the lower flanges bent round so as almost completely to enclose the supporting bars (Fig. 2). A small space is left,

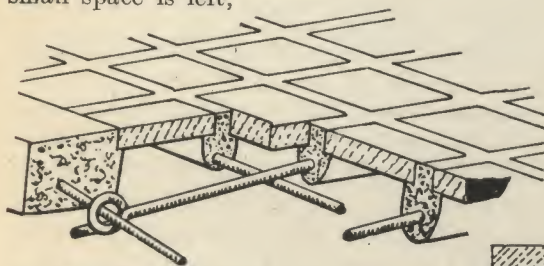


Fig. 3A.—REINFORCED-CONCRETE-AND-GLASS CEILING WITH CONCRETE BARS EXPOSED ON UNDER SIDE

is translucent, as owing to the refraction through the lenses the supporting bars buried in the glass are almost invisible.

Trouble has at times been experienced with these deep-flanged lenses, and some firms prefer to have a shallow upper lens without flanges, and to fix a second below it on the lower face of the concrete supporting-bars, the space between each square being filled with mastic (Fig. 3). This method insulates against sound

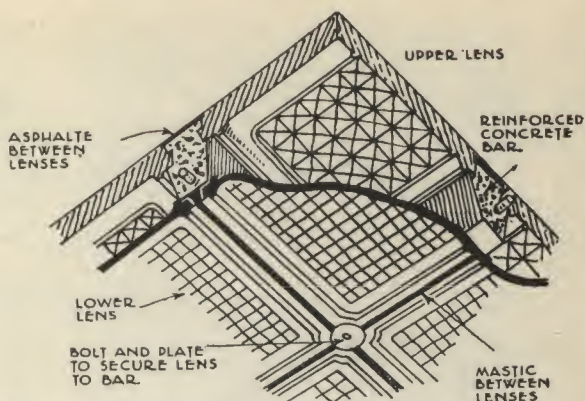


Fig. 3.—MODERN CONCRETE FLOOR AND CEILING WITH UPPER AND LOWER LENSES

Total thickness $3\frac{1}{4}$ in. Lenses $10\frac{1}{4}$ in. between centres of bars.

between each prism, about $\frac{1}{8}$ in. wide, to prevent the glass from cracking under temperature changes. But apart from these hair lines the whole ceiling, when seen from below,

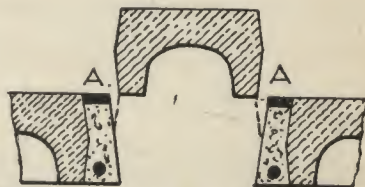


Fig. 4.—A METHOD OF FIXING LENSES WHICH ALLOWS REPAIRS TO BE EXECUTED FROM THE UPPER SIDE WITHOUT SCAFFOLD

Corners at A are chipped away and lens removed.

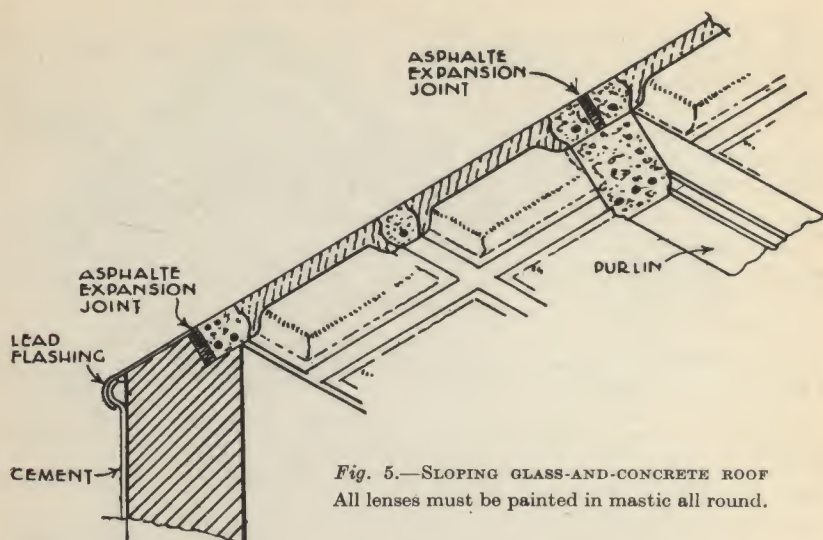


Fig. 5.—SLOPING GLASS-AND-CONCRETE ROOF
All lenses must be painted in mastic all round.

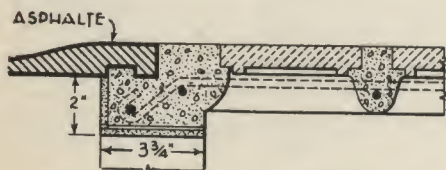
and temperature changes, and eliminates the possibility of condensation. Where these flangeless lenses are employed, the reinforced concrete has taken up practically all the stresses, but in this case the bars have to be stouter, and when looking up from below, the appearance of the black grillage of concrete against the bright glass is not always satisfactory (Fig. 3A).

Glass Roofs

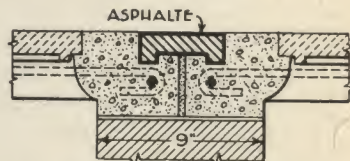
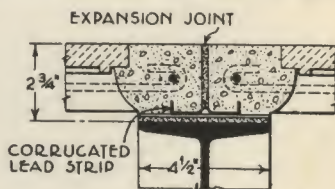
Roofing in glass and concrete can be either flat, barrel-vaulted, or pitched; in the last case, for the best appearance the rise should be

Fig. 6.—VARIOUS TYPES OF JOINTING FOR GLASS PANELS

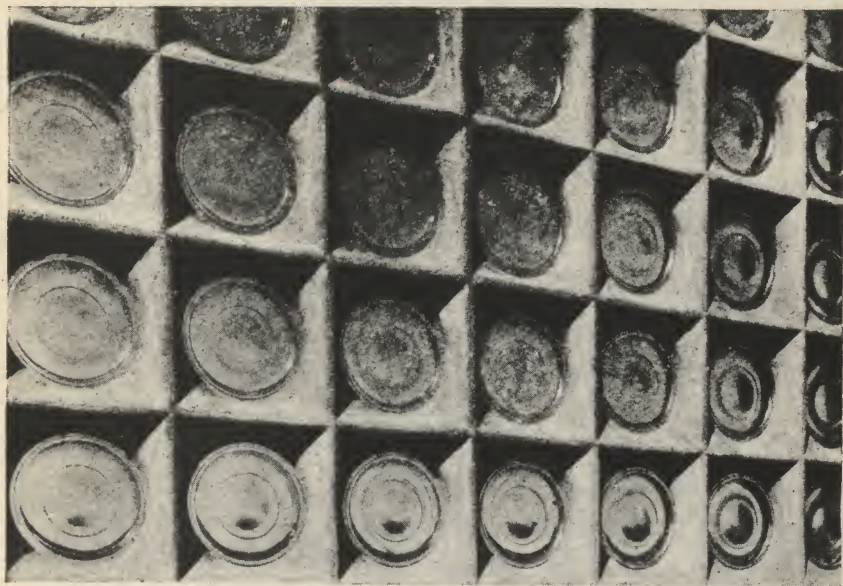
Right.—A.—Joint of panels over steel beam.



B.—Joint of glass and solid concrete roofs.



C.—Joint of panels over brick wall.



By courtesy of J. A. King & Co. Ltd.

Fig. 7.—CIRCULAR LENSES IN SQUARE CONCRETE FRAMES WITH CORNERS SPLAYED TO ALLOW OF MAXIMUM LIGHT. VIEW LOOKING UP

slight (Fig. 5). The material being homogeneous, it should be remembered that with either a curved or a pitched roof the thrust is almost negligible. One of the largest examples of flat-roof construction in this "transparent concrete" erected in England is the factory of Messrs. Boots at Beeston, where the packing hall is spanned by a concrete-and-glass roof 580 ft. long by 69 ft. wide. Each bay is divided by purlins spaced at 7-ft. 8-in. centres, and filled in with panels of concrete and glass $1\frac{1}{4}$ in. thick.

Sizes of Pressed-glass Prisms

All rectangular prisms used in these floors and roofs must have rounded corners, as under certain conditions the square edges are liable to fracture. The usual sizes of prisms are from 5 in. sq. up to 10 in. sq., and the thicknesses vary from 1 in. to $1\frac{1}{4}$ in. For floors with constant pedestrian traffic, lenses should not be more than 5 in. sq., to avoid risk of slipping.

Insulation of Prisms in the Concrete

All large, flat areas should be provided with asphalt or other mastic jointing between the concrete slabs, and special care taken where these

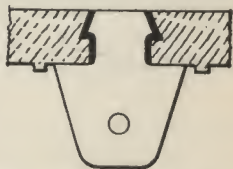
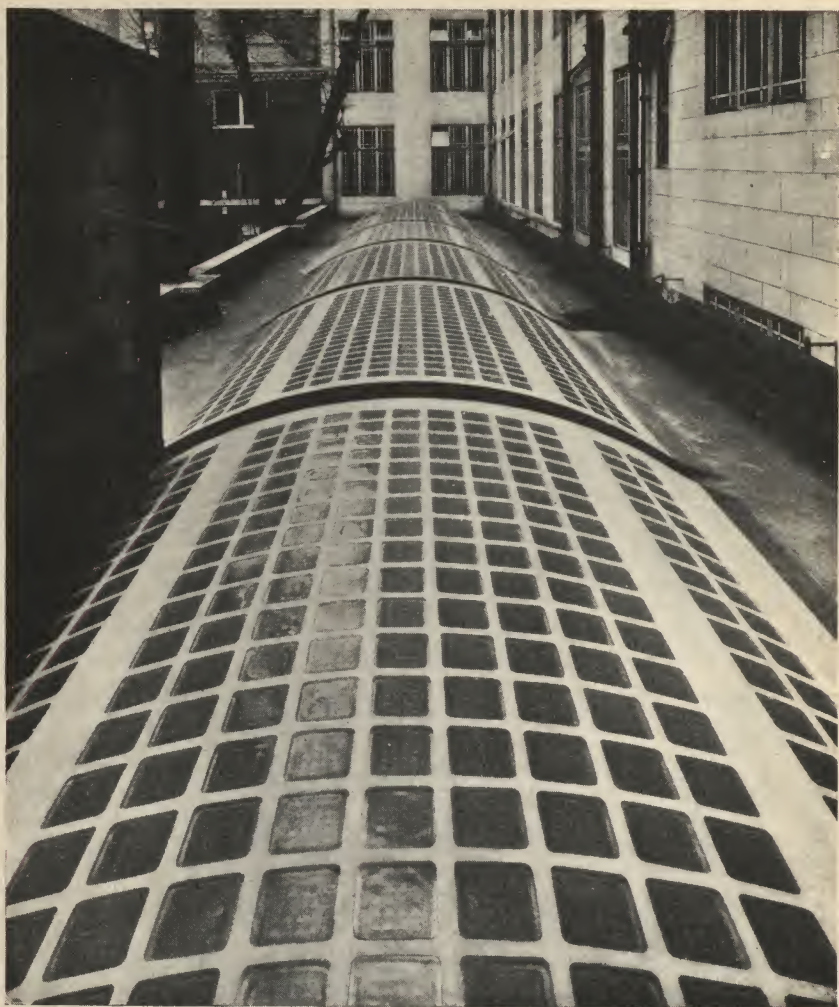


Fig. 8.—LENSES INSULATED TO THEIR FULL DEPTH WITH MASTIC COMPOUND



By courtesy of J. A. King & Co. Ltd.

Fig. 9.—BARREL VAULT IN CONCRETE AND GLASS—No. 3 ST. JAMES'S SQUARE, LONDON

joints occur over steel beams (Fig. 6A). A good method is to lay a piece of corrugated lead below the concrete immediately over the joint. Before placing the lenses, they should be insulated by painting the edges and coating them with a bituminous preparation, which is often a special material supplied by the makers (Fig. 8).



By courtesy of Lenscrete Ltd.

Fig. 10.—THE MAJESTIC CINEMA, EAST GRINSTEAD

Concrete-and-glass dome over rotunda composed of large 8-in. lenses set on the centreing with the reinforcing rods, and the concrete poured round them.

Circular Lenses

Circular lenses, of varying diameter from 5 in. to 10 in., are used in a similar manner to rectangular. In this case the lenses rest upon the usual concrete members which form the supporting mesh, but these members are sharply cut away on the under side to allow of the passage of the maximum amount of light. These circular lenses are also used for domes and vaults, but the large domes filled with an enormous number of small lenses, some 4 in. deep, are not so common in this country as in France, where they are manufactured at the St. Gobain glass works.

Constructing a Glass-and-concrete Dome

In constructing a glass-and-concrete dome, the wood shuttering is first erected in position from below. This is then covered with a coat of plaster of Paris carefully smoothed to the exact shape of the dome. On this is marked with string the position of each lens, which is then put

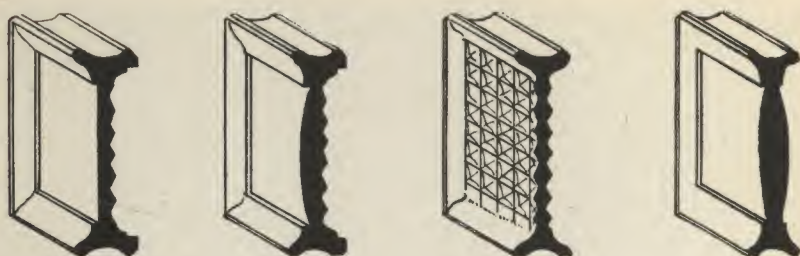


Fig. 11.—VARIOUS TYPES OF PRESSED-GLASS LENSES USED FOR GLASS WALLS

accurately in place and held fast by small tacks round its lower flange. To prevent the upper faces becoming obscured with concrete splashings, these are covered with a gummed paper before the first layer of concrete is worked in between them. When this first layer has been thoroughly trowelled all round the lenses and pressed down firmly, the reinforcing rods are laid and tied into position. The second layer of concrete is then poured in, consolidated, and finally smoothed off level with the tops of the lenses. When the initial set has taken place, the outer surface is

rubbed over, the gummed paper removed, and all irregularities filled in. Later, the centreing below is struck, and the plaster-of-Paris mould removed.

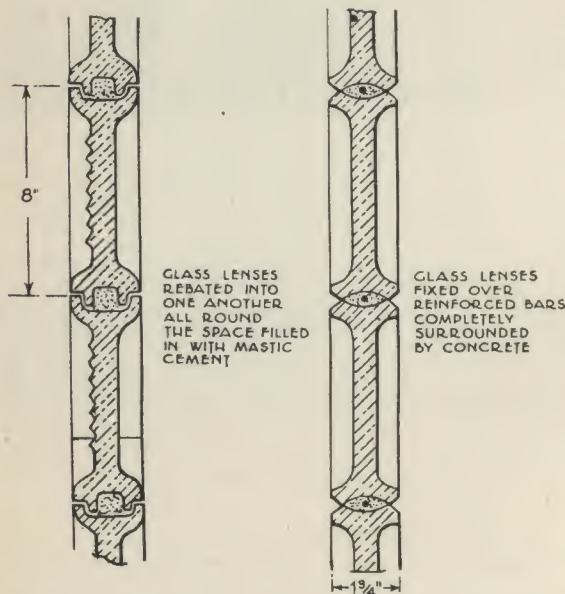
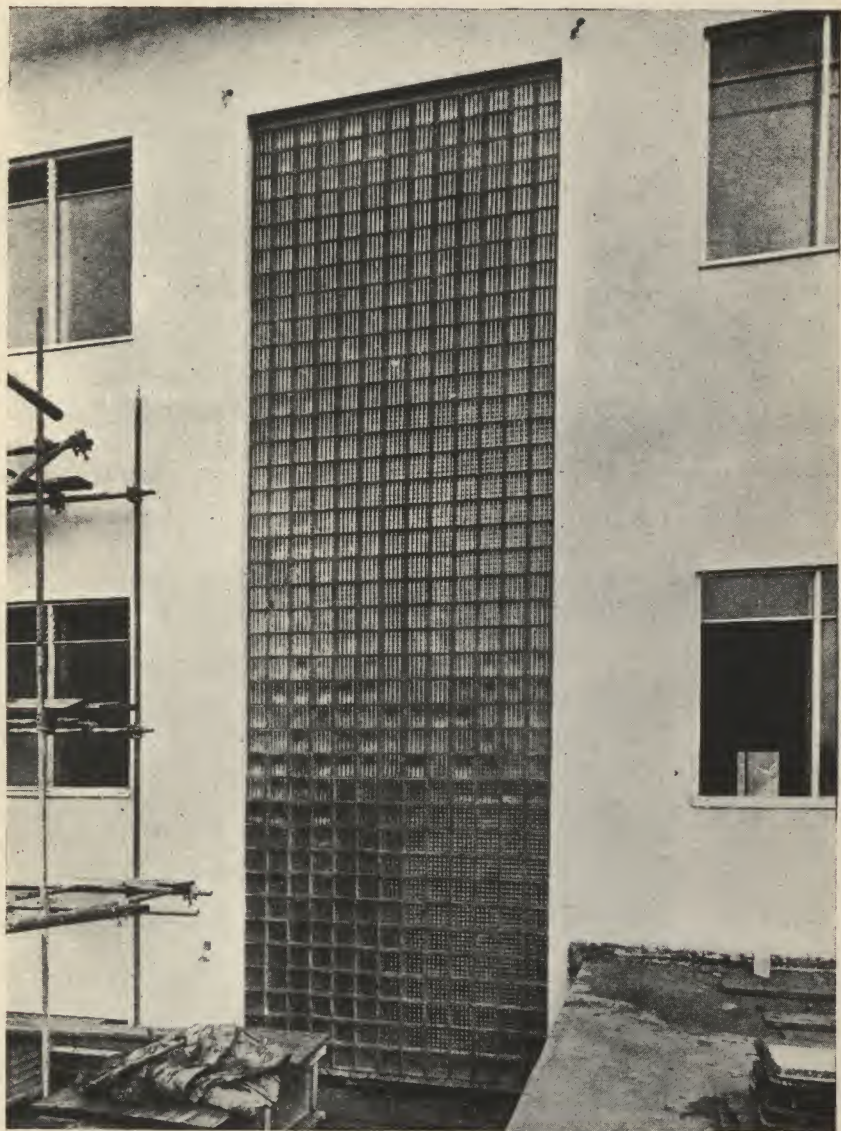


Fig. 12.—TWO METHODS OF BUILDING GLASS WALLS WITH PRESSED-GLASS LENSES

Glass Walls

The construction of glass walls differs but slightly from that of floors, for in these cases the tensional stresses on large areas of concrete and glass are set up by wind pressure. The best form of glass walling resembles an enormous window opening, filled in with a light rectangular grille of reinforced-



By courtesy of Lenscrete Ltd.

Fig. 13.—DENHAM FILM STUDIOS

Wall of laboratory, composed of concrete and glass. The thin concrete frame is reinforced with steel rods, and the glass lenses are moulded with prisms to refract the light.

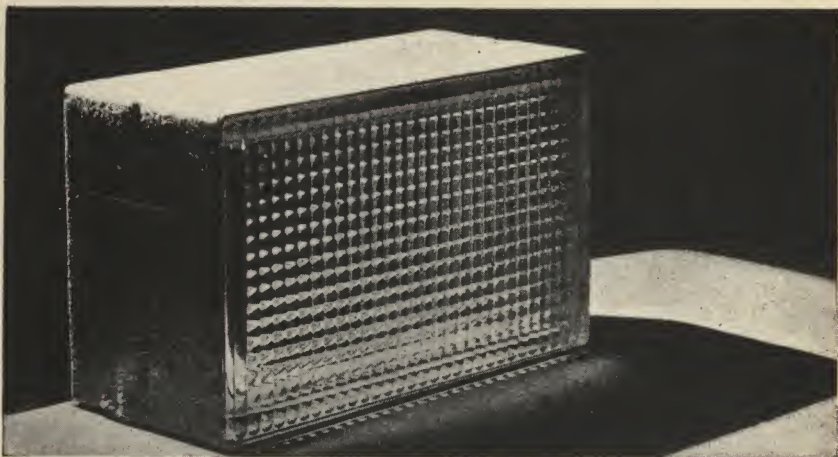


Fig. 14.—GLASS BRICK FORMED WITH TWO LENSES ANNEALED TOGETHER AND SANDED ON THE SIDES

The surface is divided into convex ribs, run vertically on outside and horizontally on inside. Size of brick, 8 in. by $4\frac{7}{8}$ in. by $3\frac{1}{8}$ in. (*By courtesy of Pilkington Bros. Ltd.*)

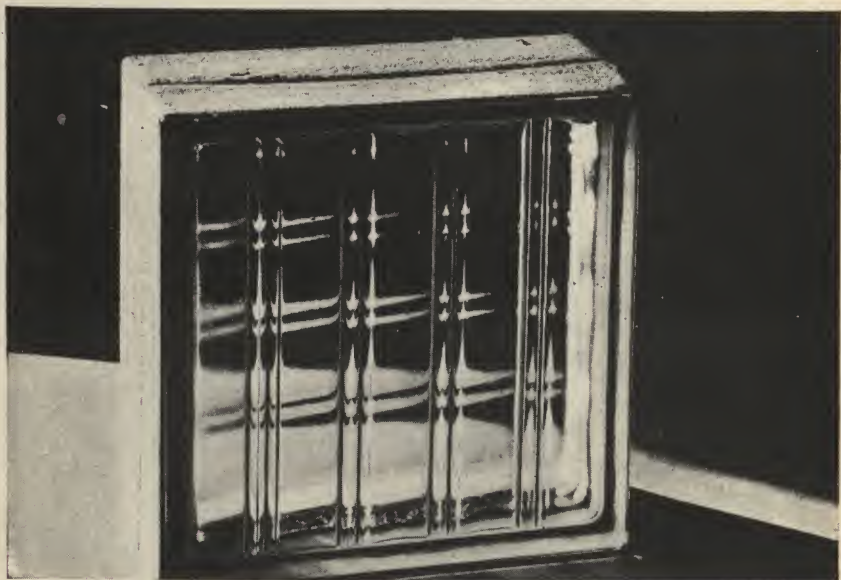


Fig. 15.—GLASS BRICK OF SQUARE SHAPE FORMED OF TWO LENSES ANNEALED TOGETHER

Each lens has a $1\frac{1}{2}$ -in. concave rib, running vertically on one and horizontally on the other. The ribs are placed on inner faces, leaving outside of glass smooth. Size of brick, $7\frac{1}{2}$ in. by $7\frac{1}{2}$ in. by $3\frac{1}{8}$ in. (*By courtesy of Pilkington Bros. Ltd.*)

concrete bars. Into this grillage the glass prisms are fitted, the prisms themselves being cast in special shapes to diffuse the light into the interior through vertically standing lenses, in place of the horizontal type employed in floorings (Fig. 11). The most usual shape is one resembling a rolled-steel beam in section, with a flange top and bottom which is hollowed so as almost to enclose the concrete bar. Smaller areas sometimes have the lenses themselves rebated on the flanges so that they fit one into another (Fig. 12). All these shaped lenses evince a tendency to crack unless well insulated from the concrete surround with mastic compound, and recent experiments tend to favour the adoption of a moderately thin lens let into a concrete rebate. This shape is not so likely to crack, and even if it does so, is easy to renew.

Internal Glass Partitions

Other forms, used for internal partitions, are constructed of glass slabs hollowed round the edges. These squares are about 6 in. by 6 in., and to erect require both horizontal and vertical reinforcing bars as stiffeners (Fig. 16).

Another type of glass wall is composed of lenses placed in pairs vertically, and rebated one over the other round reinforcing bars. This method allows an air space between the lenses, which provides adequate insulating

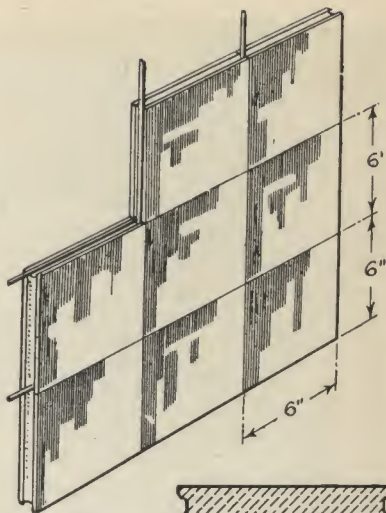


Fig. 16.—SOLID GLASS BRICK PARTITION WITH REINFORCING RODS, BOTH HORIZONTAL AND VERTICAL



Fig. 17.—SECTION OF SOLID GLASS PARTITION BRICK

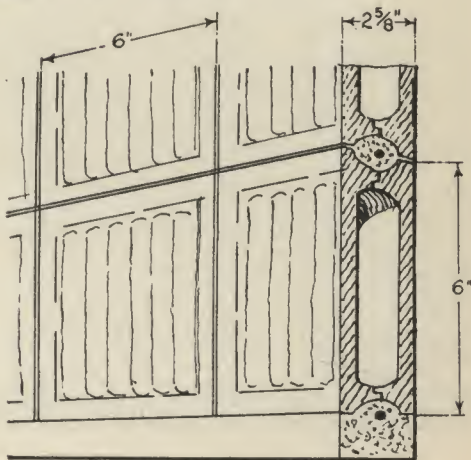


Fig. 18.—HOLLOW GLASS PARTITION WALL

Showing wall composed of lenses jointed over reinforced-concrete bars. The bottom is composed of a reinforced bar laid direct to floor. Stresses are not transferred from outer to inner lenses.



By courtesy of Lenscrete Ltd.

Fig. 19.—WAITING-HALL OF VERSAILLES RAILWAY STATION

Roof barrel vaulted in concrete and glass. The lenses are let in flush with both inner and outer surfaces of the concrete, to obtain the maximum amount of light.



Fig. 20.—MARQUISE WITH CIRCULAR LENSES

Showing hotel at Kirk Sandall, Doncaster, for Messrs. Pilkington Bros. Ltd. The building itself illustrates the application of glass as a facing to a structure consisting of brick with reinforced-concrete floors, the glass facings being opaque and in various colours (vitrolite). (*Architects: T. H. Johnson and Son, F/A.R.I.B.A.*)

properties when employed over large areas (Fig. 18). Another advantage of this method of construction is the slight amount of play existing between the lenses, so that changes of temperature acting on the outer one do not set up strains in the glass of the inner.

Glass Bricks

One method of actually building in glass is to employ glass bricks, which are really hollow cast-glass tanks. These are placed one on

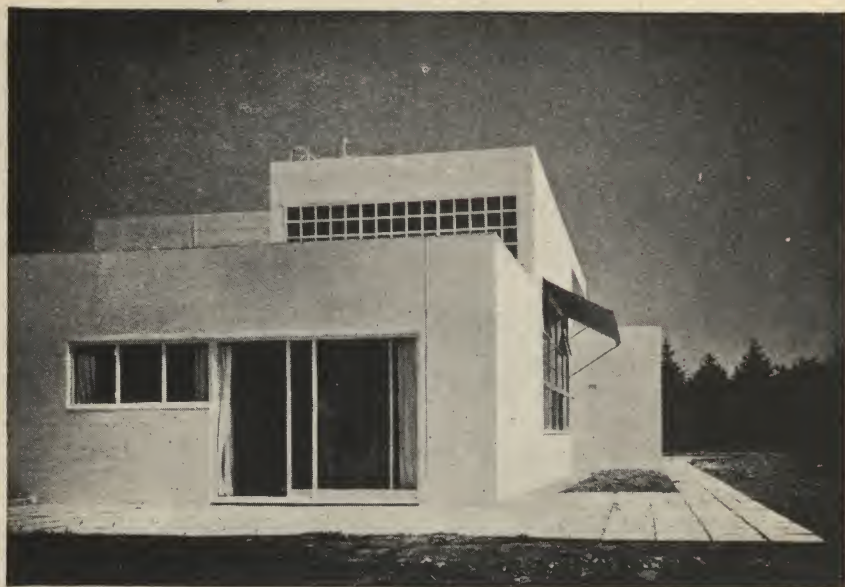


Fig. 21.—AN EXAMPLE OF THE USE OF CONCRETE-AND-GLASS WALL IN HOUSE CONSTRUCTION

A house at Hatfield, with lenserete windows high up in a part of the living-room, which extends to the roof. (*Architect : F. R. S. Yorke, A.R.I.B.A.*)

another, the open end downward, and each brick is prevented from slipping sideways off the one below by means of projecting flanges cast on to the brick. The vertical joints are broken as in ordinary brick building. Such bricks are suitable only for internal work, and must be carefully insulated by either asbestos or mastic (Fig. 22).

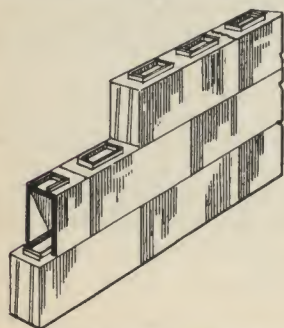


Fig. 22.—HOLLOW GLASS BRICK PARTITION

Solid glass bricks, known as Insulite, with prismatic faces, are now made, which can be built into walls or used in a variety of ways. These bricks are good light-transmitters and diffusers, owing to the variations of the surfaces. They are obtainable at present in this country in three sizes, viz. : 8 in. by 4½ in. by 3½ in. thick ; 7½ in. by 7½ in. by 3½ in. thick ; and 5½ in. by 5½ in. by 3½ in. thick. Each brick really consists of two lenses annealed together while warm. The annealed edges are afterwards sand-blasted and roughened to take the fixing cement. Two of these types have serrated



Photo: "Architect & Building News"

Fig. 23.—LIVING-ROOM OF HOUSE AT HATFIELD

This shows part of the living-room of the house illustrated in Fig. 21, looking from beneath the concrete-and-glass wall. Note how it has been possible to enliven the interior by arranging for part of the room to extend to the roof—an example of treatment for those requiring the stimulation of contrasting forms in their homes. (*Architect: F. R. S. Yorke, A.R.I.B.A.*)

or ribbed external faces, and the other is smooth. The bricks possess a high insulating property, owing to the partial vacuum inside each, and transmit from 84 per cent. to 73 per cent. of light. The edges are sanded for building in cement, and when the wall or partition is complete it has all the sanitary properties of sheet glass. They are useful in constructional work such as dairies, hospitals, stores, and industrial buildings where light is essential but divisions must be sound- and heat-proof. Further advances in this type of building will lead to further types of bricks being put on the market, and already a large American glass brick has been offered, made by the Pyrex glass firm, but the cost of building in this material is high.

In all glass-and-concrete structures the most important matter is the proper insulation of the prisms with bituminous compounds, usually supplied by the makers, and the architect should see that this compound is one that remains permanently elastic.

Chapter VII

LEADED LIGHTS



Fig. 1.—CUTTING GLASS TO REQUIRED SHAPES

Showing the original outline drawing or cut-line and various tinted glasses being cut to each portion. Allowance is made for the thickness of the plant of leads in assembling

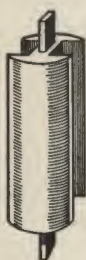


Fig. 2. — $\frac{1}{2}$ -IN.
HALF-ROUND
LEAD CALM, THE
SIZE MOST COM-
MONLY USED

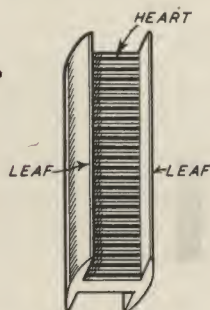


Fig. 3. — $\frac{3}{4}$ -IN.
HALF-ROUND
STEEL-CORED
LEAD CALM

THERE is an infinite variety of different kinds of glass, and it is made in many colours. The leaded-light maker usually keeps in stock those descriptions of glass for which he finds the greatest demand. Similarly, with regard to the window leads, called "comes" or "calms." There are many widths and shapes of these and the firm making up leaded lights generally have ready to hand the comes they know are most needed.

Lead Calms

While the glass is bought in large

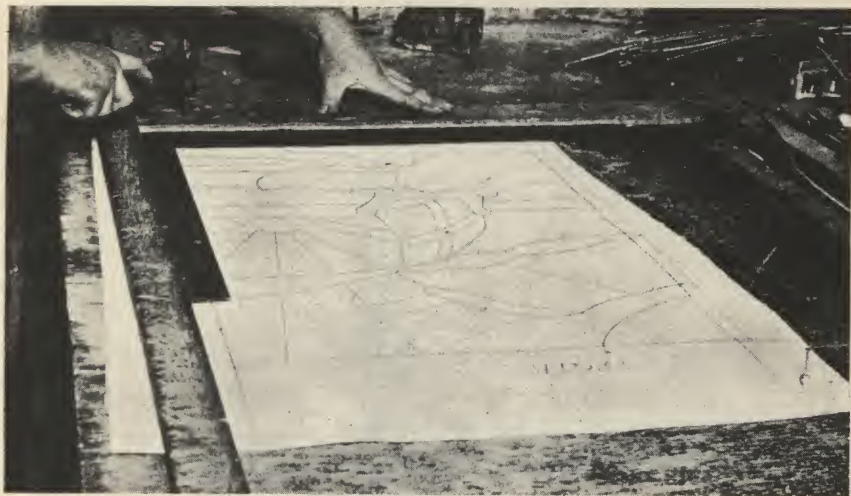


Fig. 4.—THE NEXT OPERATION

Placing cut-line in position for glazing in lead with supporting laths nailed to bench at true right angle at left-hand corner.

stock sizes from the glass merchant, and the comes can be obtained ready-made, leaded-light makers often turn out or extrude through a



Fig. 5.—GLAZING IN LEADS

All shaped leads are tightly moulded round the irregularities of the outline by hand.



Fig. 6.—GLAZING OF PLAIN DESIGNS

A thin chisel-shaped knife or cut-down palette knife is used for cutting the lead. It is held upright and at the same angle as intersecting leads.

power-driven vice the cast lead into a ribbon of cames. Figs. 2 and 3 show those mostly in use for domestic leaded lights, wider calms being generally used for ecclesiastical work. Fig. 3 also denotes the heart and leaf of the calms. Fig. 2 shows the steel core embedded in the lead calm, the use of which is explained at the end of the chapter.



Fig. 7.—THE NEXT STAGE

Light being assembled, the joints are well covered with candle-grease to prepare the cames for taking the solder.



Fig. 8.—SOLDERING JOINTS WITH ATMOSPHERIC GAS IRON



Fig. 9.—AN IMPORTANT STAGE OF THE WORK

Opening the comes with a chisel to receive the cement as shown in the next illustration, which shows the important operation of cementing.

Fig. 10.—CEMENTING LIGHTS WHEN MADE

Lights well rubbed with specially made oil cement. This binds glass and comes all together and is a most important operation, as it ensures the lights being water-tight.

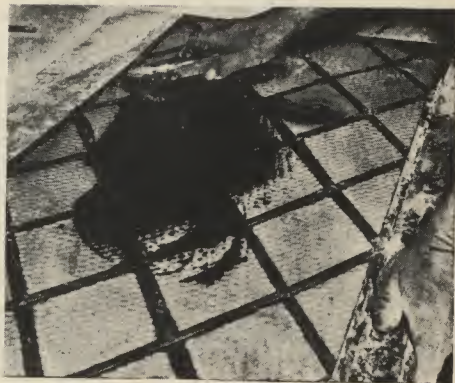


Fig. 11.—AFTER CLEANING OFF SUPERFLUOUS CEMENT A DRY MIXTURE OF PLASTER AND LAMP-BLACK TO CLEAN SURFACE OF GLASS IS WELL RUBBED IN



Fig. 12.—AFTER CEMENTING

Clean round all leads with pointed wooden stick to remove any of the cement which remains on glass.

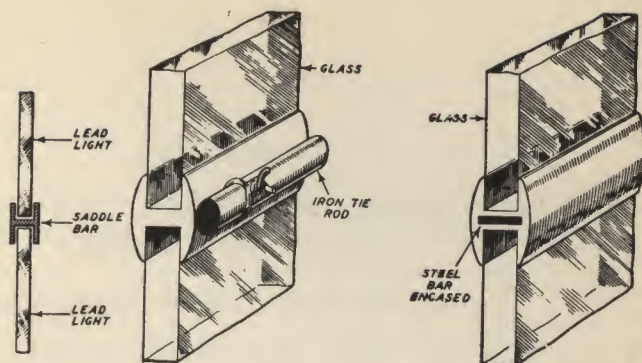
Fig. 13.—FINAL PROCESS

Well brush the surface with stiff brush. This cleans up the light, which is now ready to be fixed in its frame on a building or elsewhere.



Fig. 14.—METHOD OF SECURING LIGHT

Note with steel-cored leads no tie rods are required.



Cutting the Glass Shapes

Everything being to hand, a full-size drawing or "cut line" is made from the designer's drawing, and this is passed to the glass-cutter. The drawing or "cut line" is secured to the bench, and the glass-cutter proceeds to cut the glass to the required sizes and shapes (Fig. 1).

Lead Glazing

When the glass is cut to the design it is handed to the lead glazier, who places the "cut line" in position (Fig. 4) for glazing in the lead. Supporting laths are nailed to the bench at a true right angle at the left-hand corner. The lead glazier then assembles the glass already cut, and glazes each piece or square with lead calms (Fig. 5).

Figs. 6-13 show the glazing of plain designs of diamonds or quarries.

Cementing

Note that the cementing shown in Figs. 9 and 10 is a most important operation in order to ensure the lights being watertight.

Securing Leaded Lights to Frame

In order to fix the leaded light securely in a casement, sash-frames, or door, copper ties are generally soldered on to the calms to take one or two iron tie rods across the light, according to its size, and then the copper wire is tied round the tie rod, Fig. 13. When the form of calm used is one with a steel core, the leaded light is thus reinforced and is sufficiently strong to dispense with tie rods. With large windows, as in churches, where one light has to be built up on top of another, iron saddle-bars are generally used. These are housed into the stone at each side to prevent upper sections from settling and causing bottom sections to bulge.

Chapter VIII

FITTINGS AND FASTENERS FOR WINDOWS AND FANLIGHTS

WINDOW AND CASEMENT FITTINGS

WHEREVER joinery-made windows are used a certain amount of consideration has to be given to the types of fasteners that are to be fitted. In metal windows these are usually standard, but not so with wood sashes.

In the case of sliding sashes we have to consider the pulleys through which the sash cords run, the sash fastener to secure the windows, and the sash lifts. There are several types of these fittings, some showing a difference in quality and some a difference in the method of operation.

How to Select Sash Pulleys

A sash pulley should be chosen for its strength and ease of running, and it is recognised that ball-bearing pulleys are the best. Again, while one must not despise the old type of pulley made to receive the sash cord, there are on the market to-day various types incorporating a chain and cogged wheel. Opinions are divided as to whether these latter types have any advantage over others. It is certain, however, that slipping is prevented, but possibly at the sacrifice of quietness.

Fixing a Sash Pulley

A sash pulley is fixed in the side of a cased frame and in such a position that when the window is pushed either up or down to its maximum position the counterweight on the end of the sash cord does not foul the bottom of the frame.

The seating of the pulley should be housed into the frame so that its surface lies flush, the small projecting portion of the pulley riding in a groove in the side of the sash. Take care that the size of the sash cord used is the correct size for the pulley ; this is often a source of trouble, as a thinner cord will ride over the edge and jam between the sides of the pulley and the sides of the frame, whereas a too-large cord will prevent easy running.

Sash Fasteners

Sash fastener is the name given to the small fitting usually placed on the top bar of a bottom sliding sash and on the top of the bottom bar of

the top sliding sash, and so fitted that one piece engages in the other, thereby preventing the window from being opened from the outside. Here again we find different forms ; some are simple in their operation, but this also applies to the burglar's activities, as it was found that the old-type fastener could be easily opened by means of a knife blade inserted between the sashes.

Burglar-proof Sashes

To prevent the window being opened after this was done the old method was to use a pair of long thumb-screws screwed from the inner face of the top bar of the lower sash through to a connecting plate on the bottom bar of the top sash, thereby preventing either sash from being moved. This was a clumsy method and also took a certain amount of time. There are on the market sash fasteners which prevent this unauthorised opening, and their methods of fixing are not far removed from the old type.

Sash Lifts

Sash lifts can be divided into three types : surface fixing, flush fixing, and the pulley type. The former consists of nothing more than a handle of various shapes which can be screwed to a bottom sash to provide a hand hold.

Flush lifts, however, require a little more attention, and, as their name implies, are housed flush with the surface of the sash. Where these are fitted in pairs the distance apart is not material provided that if the sash is a wide one they are not fitted beyond the comfortable reach of a person's extended arms. For appearance' sake, however, they should be fitted evenly in the thickness of the bottom bar.

Fitting a Flush Lift

Carefully measure the size of the lift to be fitted and, having decided upon the position, mark a centre line in that position and mark half the

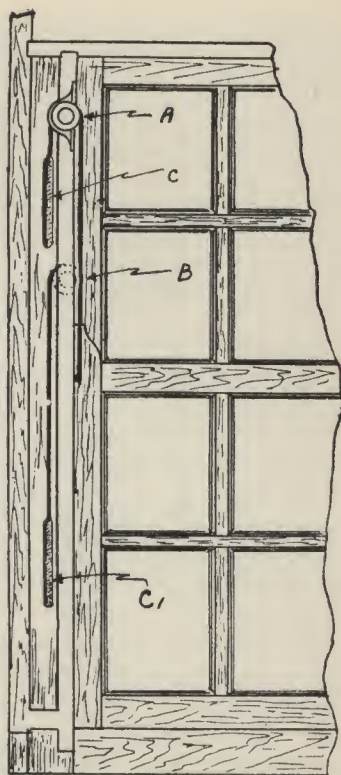


Fig. 1.—FIXING A SASH PULLEY

A sash pulley should be placed in the position A in the above illustration, so that when the window is raised the counterweight C has room to travel without fouling the bottom of the casing. If it were placed in the position B the weight C1 would not be able to travel this distance.

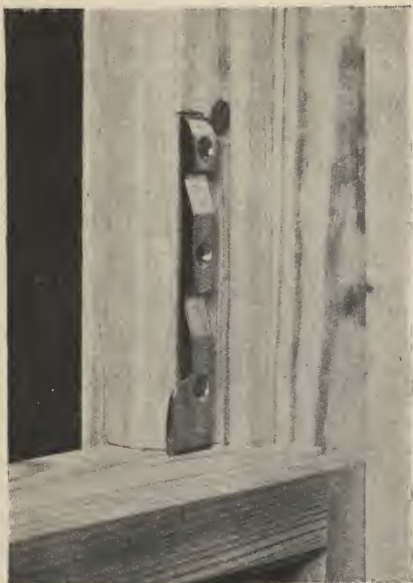


Fig. 2.—FIXING PULLEY LIFT

The first operation is to place the locking plate in position on the top sash, as shown. Next place fastener on bottom sash, as in Fig. 3.



Fig. 3.—FIXING PULLEY LIFT

The fastener is then placed on the top of the bottom sash so that it will engage in the locking plate when in the closed position, as illustrated.

length of the lift on either side of this line, squaring off two vertical lines with a square. Next mark a horizontal line dead centre in the width of the sash bar and measure half the width of the lift either side of this line. If the lift is a rectangular one, these four lines give the exact position for the sinking, and the wood should be removed with a chisel for a depth equalling the thickness of the metal.

In the centre of such a sash lift will be found a recess for the fingers, and this naturally must be sunk deeper into the wood. A proper housing must be made, therefore, for this too, making it only sufficiently large to allow an easy fit. Otherwise, if too much is removed, one may find that there is nothing left to provide a hold for the fixing screws in the corners. All this may seem very unimportant, but these points make all the difference between a workmanlike and an unworkmanlike job.

Pulley Types

Where sliding sashes are used, which are possibly large and heavy, the two types just mentioned are not suitable for the top sashes, and these should be raised or lowered by means of pulleys or cords. These

are usually fitted in pairs, one on each side of the window, to give an even pull and a locking plate is so incorporated that when the window is closed it is self-locking, and yet when opened to a certain distance for ventilation is secured in that position and prevented from being moved.

Fixing a Pulley Lift

First place the fastener on the top of the top bar of the lower sash and on its extreme edge, in such a position that it will engage in the locking plate, which must be screwed on the upright of the top sash, as is shown in Fig. 2. These two members are then screwed in position. Next screw one pulley into the head of the frame in a position that is immediately vertical over the pulley in the bottom fastener. It is essential that

this pulley must be central over this fastener, otherwise some power of the lift will be lost by reason of its being unable to exert a straight pull. The corresponding pulley should be placed in a similar position on the other side of the head of the frame.



Fig. 4.—FIXING A PULLEY LIFT

This shows the lift fixed complete. To close the window, the cord that passes over the top pulley is pulled. The other cord is used for opening, and passes under and over respectively on the two pulleys of the fastener. Pulling the latter cord compresses the spring and pulls the fastener away from the locking plate, enabling the pulled cord to draw the sash downward. The left-hand side of the sash is similarly fitted with a top pulley and cord plate, but without the fastener and locking plate, thus giving an even pull by two hands to raise or lower the window. (*Stedall and Co. Ltd.*)

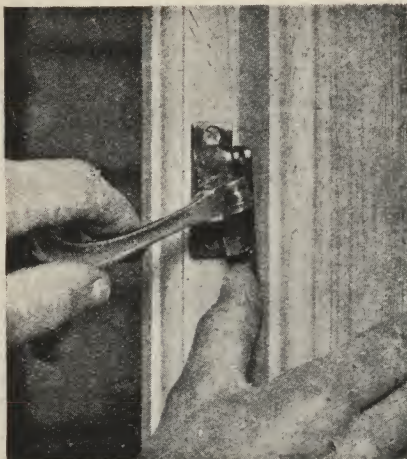


Fig. 5.—FITTING CASEMENT FASTENER

The cockspur is first screwed to the sash. With sash in closed position, gently force cockspur into frame with plate held so that tongue of cockspur does not foul bottom of the slot. Position of plate is then marked from impression left in wood.

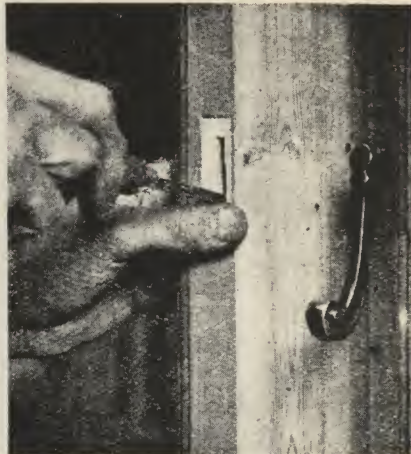


Fig. 6.—FITTING CASEMENT FASTENER

After the operations explained in Fig. 5, a mortice is cut in the frame to receive the tongue of the cockspur, and the mortice plate housed to allow it to lie flush with the surface of the frame. The mortice plate is then screwed into position.

Next take four ends of cord and pass two through each of the cord plates. With some of these, provision is made for fixing the cords on the bar. With others, the cords must be knotted before screwing the cord plate to the uprights of the sash in a position at about two-thirds of its height but level with each other horizontally. Now pass one each of the cords over the pulleys in the head of the frame. The remaining cord on the fastener side is passed under the pulley, through the operating catch, and over the other pulley.

Now test by pulling the two shorter of the cords, and these should release the catch and draw the sash downward. A pull exerted on the other two cords should raise the sash, and if the fastener has been properly fitted it will automatically engage without any further attention from the operator.

Casement Window Fastenings

In this type of window the question of raising and lowering is non-existent, but merely the fastening in a closed or open position. For the former a fastening known as a cockspur is used, and for the latter a casement stay. Of the former the type most used is that having a plate which is fitted over a mortice cut in the casement frame, and the tongue of the cockspur is fitted to it. When selecting one of these, be sure to get one with a good, bold handle.

There are plenty on the market at ridiculously low costs, but if compared with one for which a few pence more is given it will be noticed that the material has been skimmed to such a degree as to make it difficult even to hold firmly in one hand.

Fitting a Cockspur

When fixing a casement fastener the cockspur should be screwed in position on the sash in such a position that a fair amount of the tongue will engage in the mortice and not merely the point. When this is done the position at which it hits the frame should be marked with the mortice plate held in position, to ascertain that the tongue will not foul the bottom of the plate as it is withdrawn. The suitable position having been found, scribe around the inside and outside of the plate at this point, cut a sufficiently deep mortice in the centre position first, and then remove sufficient of the wood around it to house the plate.

If the mortice plate supplied has its opening wider than the thickness of the tongue (which should not be the case, except for slight clearance), the mortice plate must be fixed in such a position that the cockspur will tend to draw the casement closely shut. This is done by setting the plate a little farther away from the sash towards the inside of the room.

Casement Stays—the Old Type

The oldest type of casement stay is one that employs a hinged bar drilled at intervals with holes made to fit over a pin fixed on the bottom of the frame. The back hinged portion of the arm is fixed to the sash, and when the window is opened the pin is made to engage in any one of the holes at will, thus holding the sash firmly in given positions. In the use of this type it is impossible to hold the window in "any" position, more especially at the "slightly open."

Sliding-bar Type

There has, therefore, been designed a casement stay with a sliding bar and a thumb-screw, by means of which the bar is clamped at any position along its travel. How the bar is made to travel is a matter of manufacture: in some cases it is telescopic, in others it slides through a slotted member fixed to the bottom of the frame.

Fixing the Stay

When fixing the former variety one or two pins may be used, but two are recommended. Study Fig. 7, which shows the figurative positions of a casement opening on one pin only, and then study Fig. 8, which shows the same casement opening on two pins. It will be noticed that in the latter a greater number of positions is offered than by the use of one, and further, the extra pin helps to draw the casement closer by preventing the bar slightly swinging on the axis that would be provided by one pin only.

A Friction Casement Stay

Among the many designs for casement stays the "Woodlock" patent "stay-put" fitting has many uses, although its principle, that of applying friction to the hinge of the sash or door, is

Fig. 8 (below).—
FITTING CASEMENT STAYS

If a casement stay is fitted with two pins, the relative opening positions are increased as against those shown in Fig. 7.

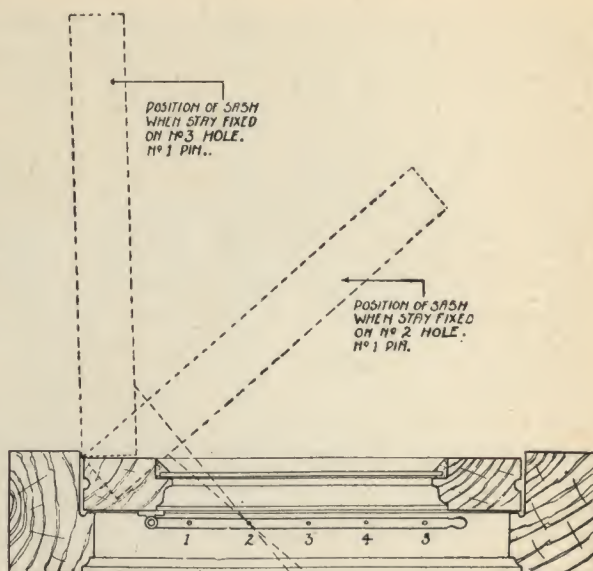
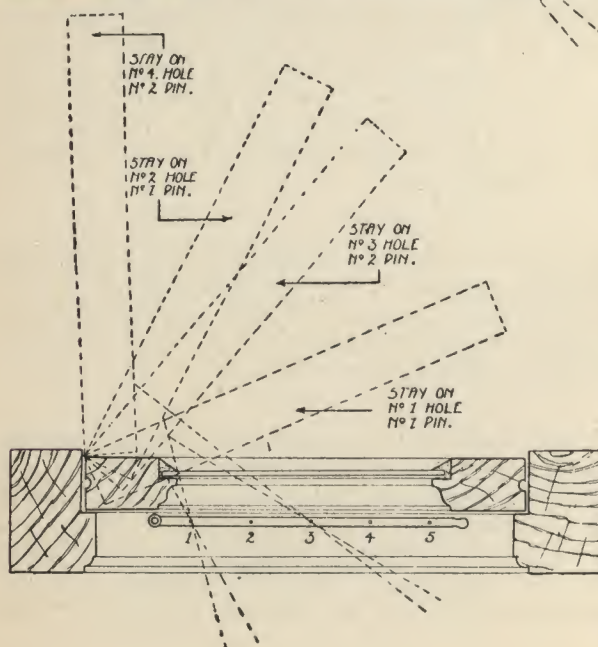


Fig. 7.—FITTING CASEMENT STAYS

The above illustration shows the limited opening positions when a casement stay is fixed with one pin.



the same in most of them. There are two patterns of this particular style of fitting, one with an adjustable joint and the other without. The adjustable scheme is the better, and makes only a slight difference in the cost. The first-mentioned type has a hinge bolt

with winged nut, by which the pressure on the fibre washers contained in the friction joint may be altered to any desired amount. The joint of both is also designed in such a way that the continued movement of the hinge cannot unloose any of the moving parts which provide the friction.

Fitting Friction Stay to Door

For a casement sash or a door that is particularly subject to wind—most are, by the way—and which is required to be left in a partly open position, this fitting can be recommended. French folding doors

which open to a garden are an example of this, and also almost all casement window sashes. In the case of doors the fittings would be placed at the top; and the projection of the fittings inwards from the face of the doors when they are closed must be considered in respect to any curtain-hanging schemes that may exist or are proposed.

The fitting is shown in Fig. 9 open. The two arms of the stay are as nearly as possible directly over each other in the former position, and the mechanism is provided with stops which limit the opening of the sash.

To choose the correct position of the fitting for its attachment to the sash and the lining of the opening, it may be clamped to an ordinary 2-ft. rule as shown in the accompanying Fig. 10. Slacking off the friction joint, it may be placed in various positions, and the angle of movement directly observed. The distance of the fixings on both parts of the window may also be read off in inches from the centre line of the hinge.

For a "top-hung" sash, the movement required is usually less than in the ordinary case, i.e. for a door or window hinged at the side,



Fig. 9.—FRICTION CASEMENT STAY WITH WINDOW OPEN



Fig. 10.—FINDING CORRECT POSITION FOR FITTING TO CASEMENT



Fig. 11.—FITTING ESPAGNOLETTE BOLT

The first operation in fixing the bolt. The two sliding rods are placed on the pins at the back of the handle and the whole then screwed to the door. The bolt is placed on the door that holds the inner rebate in position.



Fig. 12.—FITTING ESPAGNOLETTE BOLT

The next step in fixing the bolt. The keepers are placed at equal distances along the length of the rod according to their number. Finally the keeper is drilled in cill, if doors fold over rebated cill, or special keeper is provided.

and therefore the fitting may be placed farther away from the hinges.

Using as a Casement Lock

The "Woodlock" fitting may be used as a casement lock by fixing 2 $\frac{3}{4}$ in. from the hinge post of the sash with both arms directly over each

other when the window is closed. By swinging the fitting over the centre the sash is locked. This is an advantage which will, however, not dispense with the usual casement fastener, and applies to the use for ordinary windows only. An extra-heavy pattern of this fitting is made for doors larger than those used for domestic purposes.

If a top-hung sash is very wide in comparison to its depth, two stays, one on each side, are recommended.

CASEMENT DOOR FITTINGS

Casement doors differ in action from casement windows in that there are a pair of doors hung folding and rebated at the meeting styles, and there are several methods of fastening. The cockspur is useless unless employed in conjunction with bolts. If it is desired to use the cockspur, then a pair of bolts must be fitted, one at the top and one at the bottom on the first closing door, the second door closing over the rebate. A cockspur can be used by having a hook plate in lieu of the mortice plate described.

Whether the bolts used are straight or necked depends upon the formation at the cill and head of the frame. If these are rebated and the casements open outward, then necked bolts should be used to give the best job, although the writer has seen the rebate cut away and an ordinary barrel bolt placed sufficiently low on the door to engage in the body of the cill. This is not practical carpentry, but bodging.

If the casements open inward and the cill projects above the floor, the inside face of the door being flush with the back edge of the cill, then a barrel bolt and its keeper can be used. Again, if the back edge of the cill is flush with the floor and the casements open inward, a barrel bolt and eye plate placed on the floor can be fitted.

Fitting Espagnolette Bolts

It is at all times doubtful, however, whether the cockspur is a satisfactory fastening for casement doors, and there is no doubt that the espagnolette bolt holds the premier position. It is true that the initial cost is greater, but the method in which it does its work is sufficient recompense for this. An espagnolette bolt fitted to a pair of casements provides a fixing at the top and bottom of both doors at once by reason that the first closed door cannot move, as the outer rebate holds it in position, and the bolt is fitted to this second door.

There is nothing difficult in the fixing of an espagnolette, the most important factor being perfect alignment. The bolt should be fitted perfectly upright and the brackets or fixing pieces placed in their true relation to the sliding rod.

With some of the more elaborate patterns it is wellnigh impossible to fix these bolts in any but the correct method, as there is sometimes a solid casing from top to bottom, but in the cheaper forms where bridges are used

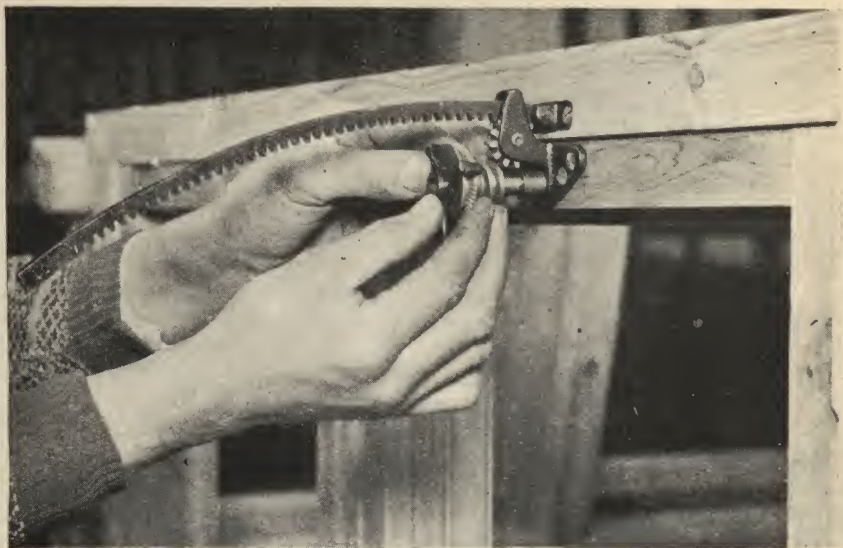


Fig. 13.—FITTING LEGGOTT'S FANLIGHT OPENER

A Leggott's fanlight opener for a bottom-hung fanlight opening inwards is shown being fitted. The mounting is first disassembled to allow access to the screws, and is then fixed in position as shown.

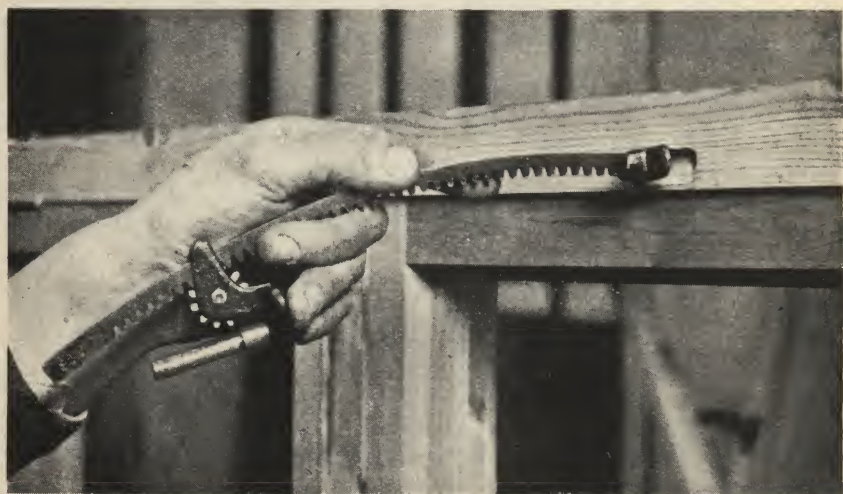


Fig. 14.—FITTING LEGGOTT'S FANLIGHT OPENER

Where the sash is recessed, the hinged back plate must be housed to the frame of the fanlight so that its back edge is in the same vertical plane as the face of the sash, as is shown above.

at intervals, unless these are fixed in true relation, the sliding bar will have a tendency to bind. The methods of fastening must again differ according to the specific surroundings; the top and bottom of the bolt can be made to shoot either into a mortice cut into the head of the frame and in the cill, or into a keeper provided.

IRONMONGERY FOR FANLIGHTS

Fanlight Openers

In describing fanlight openers we will confine ourselves to those that actually assist the opening, although, as an example, a fanlight catch operated with cords used in conjunction with a pair of quadrants is really a fanlight opener. There are, however, mechanisms that can be fitted to fanlights which will open or close them to any desired pitch, whether they be top or bottom hung, vertical or horizontal, inward or outward opening. As there are innumerable makes to suit each of these conditions, chief principles must suffice.



Fig. 15.—"SHERIFF" FASTENER IN POSITION ON TOP-HUNG OUTWARD-OPENING FANLIGHT

The position and method of fixing are clearly seen.

<i>Size or Type of Opening</i>	<i>Distance of Travel</i>	<i>Length of Bar</i>
Fanlights up to 2 ft. square	10 in.	12 in.
Ditto up to 3 ft. square	15 in.	16 in.
Heavy Fanlights	18 in.	21 in.
Skylights up to 2 ft. by 1 ft. 3 in. ..	10 in.	12 in.
Ditto up to 3 ft. by 2 ft.	15 in.	16 in.
Heavy Skylights	18 in.	21 in.
Extra-heavy Skylights	21 in.	24 in.

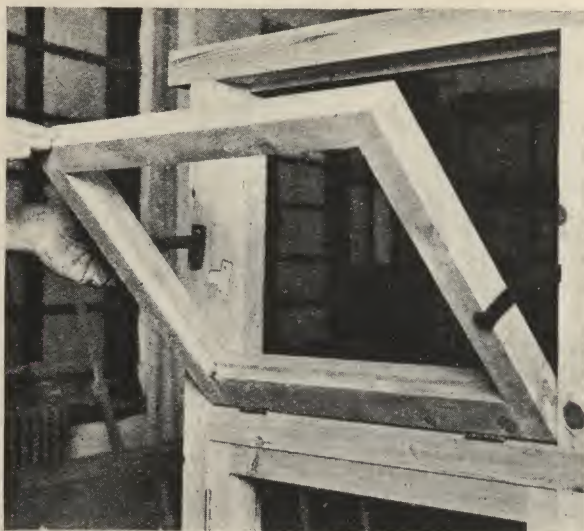


Fig. 16.—FITTING
FANLIGHT QUAD-
RANTS

Fanlight quadrants are mostly fixed to fanlights opening inward, unless the fanlights open outward into an area sheltered from the weather. The fixing plates are housed in the side of the frame in the position shown above.

only the wheel to revolve, the serrated bar must move inward, outward, upward, or downward any distance according to the number of times the wheel is revolved and the type of opener used, those traveling upward and

Leggott's System

The first, and that in most common use, is known as Leggott's system, and consists of a worm—revolved by means of an endless cord—which, in its turn, revolves a cogged wheel; this wheel, in its turn, travels along a serrated bar. In this type the cogged wheel and worm are placed on a mounting and the mounting made a fixture to the frame

of the fanlight. As this mounting is fixed, allowing

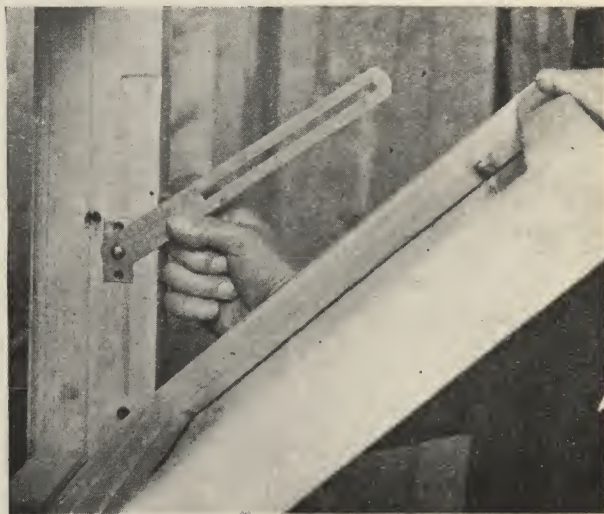


Fig. 17.—FITTING A SHADBOLT STAY

The stay is folded out of view when fanlight is closed. Riveted end of arm is housed to inside of frame, as shown, while sliding end is attached to sash by means of screw, a loose plate being housed into side of sash.

downward being known as skylight openers. The usual lengths of these serrated bars, the distance to which they open, and the typical size of fanlights or skylights for which they are to be used is given in the Table on page 101.

Fitting a Fanlight Opener

The actual fixing of any of these openers should present no real difficulties. In the case of a bottom-hung fanlight opening inward it is first essential to fix the mounting holding the worm in position on the centre of the top bar of the fanlight, which should then be closed. The serrated bar has a back plate hinged to it.

This back plate is screwed to the frame, and the action of the hinge allows the bar to drop and remain engaged loosely with the cogged wheel as the angle of the fanlight varies during its opening. It should also be mentioned that the bar is slightly curved to correspond with the arc described by the fanlight. The same principle of fixing is universal throughout Leggott's system, whichever type of opener is used.



Fig. 18.—TELESCOPIC FANLIGHT OPENER
Showing fanlight being opened by long-arm attachment. (*Skylux Ltd.*)

Fitting a " Sheriff " Opener

There are other types of openers, some of which give a more limited amount of opening both in space and number of positions, and one such is known as a " Sheriff " patent fanlight opener. The space of opening when using a " Sheriff " opener depends upon the position at which it is fixed, for while the maximum amount of opening can be obtained when it is fixed at a point nearest the hinges, the ease with which it is opened is considerably lessened.

In large works, systems of gearing are used so constructed as to open several fanlights or skylights at once, but these are usually supplied and fixed by specialist firms and rarely come within the scope of the carpenter and joiner.



Fig. 19 (above).—FITTING "SKYLUX" TELESCOPIC MULTIPLE GEAR TO FANLIGHT

Marking position of the telescopic pull member, after which it is screwed down. It is important to note that the light should be in the closed position and the telescopic pull member should be out to its full length when fixing the latter. If this is not done, the extent to which the fanlight can be opened will be curtailed.

Fig. 20 (below).—FITTING "SKYLUX" TELESCOPIC MULTIPLE GEAR TO FANLIGHT—FIXING THE GEAR BOX INTO POSITION

This is simply attached to the end of the telescopic pull member and screwed, as shown. Multiple gear can be made to operate a number of fanlights in line by extending the rolling bar and fitting the necessary brackets and elbows to each sash. Centre- and bottom-hung fanlights can also be operated by means of the gear illustrated in Figs. 19 and 20.



Fanlight Stays

While on the subject of fanlights, other articles of ironmongery used in conjunction with these are various types of fanlight catches, quadrant roller, and other stays.

Fanlight catches are the simplest of all stays, the fixing plate being housed into the side of the frame with its surface flush. The fanlight is held closed by means of a spring catch operated by hand or long arm. These quadrants can be obtained in various sizes, each giving a different angle of opening. They have the disadvantage, however, of being unsightly, as they always remain in one position and cannot be tucked away. To overcome this, another type is used having a slotted bar riding on a screw. This bar is fixed by means of a pivot to a back plate housed on the inside of the frame, and a plate having a detachable screw is fixed on the side of the sash.

One type can only be used for fanlights hung at the bottom. There is another type which is an adaptation of the same principle, but the top edge of the slot in the bar has grooves or notches cut in to prevent a top-hung fanlight closing of its own accord.

Fixing the Stay

In fixing one of these stays, the position varies according to the angle at which it is desired that the fanlight shall open, in conjunction with the length of the stay. Having determined this position, place the stay on the inside of the stile of the frame of the fanlight and mark the position of the back plate, at the same time making a point where the bottom of the slot occurs. Make a small sinking of sufficient size to accommodate the back plate so that the surface lies flush.

Now measure the distance from the top of the inside of the frame to the point marked at the bottom of the slot, and measure this same distance on the outside of the sash. This point gives the centre of the plate with the detachable screw. Remove the screw from this plate and place it over this point, which will be seen through the centre hole, and again mark out the size of the plate, sinking flush as before. Having placed the fixing screws in position, raise the bar so that the slot is immediately over the hole in the plate on the side of the sash, and replace the screw.

If an attempt is now made to close the fanlight it may be found that this screw fouls the inside of the frame and a small slot must be cut to receive it. The fanlight should be fitted with a pair of these stays, otherwise the weight will tend to twist the frame when it is open.

Conclusion

We have now dealt with the chief points which are likely to be met with by the practical man who is concerned with the fitting and repair of windows of all types.

New types of windows, fittings, and fasteners are placed on the market from time to time, and the only way in which the builder can keep in touch with these and other developments in the industry is through the pages of the trade and technical journals catering for builders.

Only time can tell whether any particular development will fulfil the hopes of its inventor. In the present book no attempt has been made to cover every conceivable type of window fitment. Representative types have been selected from amongst those which have proved their worth in actual practice.

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